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Individual Energy Consumption Behavior Leads to Energy Sustainability in Malaysia

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Abstract: Malaysia ranks third in the world in terms of carbon emissions, with an average annual rate of 4.7 percent. There is a strong need to understand the challenges and motivations for energy consumption change at the individual level. This study aims to investigate the relevant factors affecting Malaysian individual energy consumption behavior towards energy sustainability using the multi-criteria decision-making methodology of the Analytic Hierarchy Process (AHP). The data were collected from 121 experts using a purposive sampling technique. A framework is developed by assigning weight to the selected factors and sub-factors based on their relative importance in pairwise comparison matrices. The results showed that there were five main factors influencing individual energy consumption behavior in Malaysia, where education was ranked as the top priority, followed by institutions, social values and norms, social structure, and lastly, lifestyle. There were also 16 relevant sub-factors ranked from top priority to least priority (environmental concern, ecology knowledge, energy policy, environmental consciousness, energy tariff, energy efficient technology, morals, social class, location, culture, ethics, choice of lifestyle, personal materialism, gender, ethnicity, and spirituality). Policymakers will be in a better position to design intervention strategies for energy sustainability through energy policy if they understand individual consumption behavior.

Keywords: energy consumption; consumption behavior; sustainability; framework; co-creation

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1. Introduction

Energy is used extensively in modern social and economic activities and lives. Malaysia's energy consumption stood at 14.5 million tons of oil equivalent (Mtoe) in 1990, 45.6 Mtoe in 2007, and is projected to rise to 116 Mtoe in 2020. CO_2 emissions were recorded at 43.7 Million Tons of Carbon Equivalent (Mt-c) in 2007 and are estimated to reach approximately 86 Mt-c by 2030 [1–3]. If we continue to live our current lifestyle, our energy consumption will certainly rise. To achieve energy sustainability, focusing solely on efficient technology for production, delivery, and consumption is insufficient [1]. Similarly, a combination of fossil and renewable energy sources is insufficient, given the slow rate of expansion in renewable energy output. When society demands less energy, the pursuit of energy sustainability will succeed. Previous research has found that household consumption accounts for 72 percent of global greenhouse gas emissions, implying that individual energy use must be drastically reduced [2]. Previous study found that individuals' energy consumption behaviors have a significant impact on energy demand. According to the study, roughly 20% of total electricity consumption can be reduced by changing individual behavior [3]. Another study discovered that minor changes in individual energy consumption behaviors can result in energy savings ranging from 10% to 20% [4]. Therefore, individual behaviors are crucial to understanding how energy consumption

and environmental pollution are impacted [5]. Individual energy consumption can be reduced using two techniques, which are improving energy efficiency and increasing energy supply. With the advent of climate change and environmental deterioration as a result of excessive energy usage, energy efficiency is becoming increasingly important [3]. The development of energy-efficient technologies and new energy-related technical innovations will not be enough to remedy the environmental damage. Governments continue to invest a significant amount of money in the production and distribution of energy resources while ignoring the end-users or energy consumers [4]. As a result, changing individual energy consumption behaviors to conserve energy could help to minimize climate change and environmental degradation issues [5]. Respectively, it implies that the right values towards the environment and sustainable energy consumption behavior are equally pertinent. These values and factors include ecosystem knowledge, environmental concerns, religious salience, spirituality, moral values, ethics, personal materialism, lifestyles, information, and awareness [6,7].

Energy consumption is the amount of energy used in various sectors of the economy, which contributes to global warming and climate change. The availability of sufficient and affordable energy stimulates customers to consume energy at a high pace, necessitating energy management [4]. The amount of energy consumed is influenced by individual behavior, which, invariably, is unpredictable [4,5]. Individual energy behavior refers to a person's capacity to influence their surroundings through energy consumption. In other words, energy consumption, which is critical for long-term sustainability, may be used to address climate change and pollution issues [8]. The term "sustainability" refers to a company's efforts to apply sustainable standards throughout the whole value chain [9]. Previous research has revealed several gaps in our understanding of various sociocultural elements, such as environment, lifestyles, and energy consumption behavior. Other aspects, such as cognitive heuristics, emotions, moral and social norms, and personal core values, have also been mentioned in recent psychological and consumer behavior studies [10].

For researchers, practitioners, and politicians, household energy conservation has emerged as a major challenge and opportunity. Consumers appear to be becoming more aware of the value and necessity of sustainable energy practices, especially as public concern about greenhouse gas emissions and climate change grows. Despite having the knowledge on how to save energy and a stated desire to do so, many consumers fail to take significant measures toward energy efficiency and conservation. People's self-reported knowledge, values, and attitudes often differ significantly from their observed behavior. However, financial incentives and the rational pursuit of material interests are not the primary drivers of household energy usage. In reality, rewards and sanctions designed to modify consumers' cost–benefit equation in favor of sustainable behavior can occasionally elicit unanticipated and unfavorable responses. Understanding consumer needs and energy consumption behavior through value co-creation can help policymakers design more cost-effective and mass-scalable behavioral solutions to encourage consumers to use renewable and sustainable energy sources, as well as make household and community responses to public policy interventions less surprising. Co-creation incorporates the firm and its network of other entities, such as customers, suppliers, and distributors, working together to create value. As a result, individual and organizational behaviors and interactions lead to innovations [11]. Co-creation among a variety of stakeholders in energy consumption allows for successful energy sustainability. It is essential to deal with the expectations of the people involved in the co-creation process. Consumers are considered the biggest stakeholders in energy usage. Thus, understanding the consumer's behavior would help in attaining successful energy sustainability.

Furthermore, and perhaps most crucially, scientific research has a limited understanding of the various facets of energy consumption behavior. Therefore, this study will investigate individual energy consumption behavior by considering aspects of societal structures, institutions, education, social norms and values, as well as lifestyle. The integration of multiple criteria and ambiguous information necessitates a framework and

expert judgement. Adoption and implementation of a well-structured analytical framework has the potential to increase the transparency, analytic rigor, auditability, and conflict resolution of decision makers. As a result, the relevant elements affecting individual energy consumption behavior, such as social structure, institutions, education, social values and norms, as well as lifestyles and their sub-factors, will be organized in order of priority in the framework's outlining. The framework will guide government institutions and other key stakeholders in formulating policies, allowing them to make decisions based on the identified relevant criteria and take additional actions to address individual energy consumption behavior in order to achieve energy sustainability.

Theoretical Underpinning the Study

In psychology, energy consumption behavior differentiates between single-shot energy-related decisions and everyday energy-related behaviors, such as showering behavior or commuting, that are, to a larger extent, characterized by automatic habits and routines and may, thus, be differentially influenced by psychological factors [12]. Psychological perspectives, in general, highlight the importance of elements such as belief structures, value systems, attitudes, emotions, and social norms in determining and regulating energy-related decisions and behaviors. Within psychological theories, the Theory of Planned Behavior (TPB) postulates that decisions and behaviors are the result of a process that weighs the costs and benefits of the behavior, considering factors such as attitude toward the behavior, perceived behavioral control, and norms held by significant reference people [13]. TPB has been effectively utilized to forecast a variety of behaviors, including energy-related behaviors such as energy conservation. Human–environment interaction has a complex structure in which behavior is influenced by both the individual and their environment. Before evaluating consumer behavior and its impact on energy use, it is critical to characterize this complex interaction. The values, attitudes, and beliefs of a person influence their behavior [14]. There is a knowledge function that exists between attitudes and conduct, and it is defined as awareness, or understanding, of someone or something based on information, or descriptions, received through education and experience. This is all directed at self-selection, whereby self-selection effects can be defined as individuals' chosen lifestyle-related decisions regarding work, home, and family. These choices contribute to people's quality of life, which is influenced by their attitude, belief, consciousness, and sociodemographic characteristics. The study discovered that characteristics such as employment, household composition, end-use ownership, technology selection, and associated expenditures all contribute to increased energy consumption [15]. Energy consumption behavior is also linked to cultural practices, as energy-related activities influence how material culture is used to influence individuals' cognitive norms, such as beliefs and understandings.

Current research on individual energy consumption behavior towards energy sustainability in Malaysia focuses more on individual consumption and conservation of energy used for sustainable future. The conceptual model of individual energy consumption behavior proposed and adopted by the current study has reflected upon the work fall under theory of planned behavior decision support model of prescriptive model under cognitive consumer behavior models. This theory employed six constructs including attitude, behavioral intention, subjective norm, social norms, perceived power, and perceived behavior control [14]. This study uses an analytical approach towards energy conservation by identifying the key factors and sub-factors that lead to individual energy consumption behavior. A wide range of factors and sub-factors have been included in the individual energy consumption behavior framework, with literature support to justify their inclusion to better understand and explain the consumer behavior. The conceptual framework for this study, considering the theoretical framework and the findings from the literature review, is illustrated in Figure A1.

2. Materials and Methods

This study analyzes the individual energy consumption behavior, whereby multi-criteria decision-making is employed to cope with the imprecision and vagueness of information on the individual energy consumption behavior evaluation process. This study proposes an analytical hierarchy process (AHP) [16,17] to obtain a consistent flow of answers through the results of questionnaires. The Analytical Hierarchy Process (AHP) has been largely applied to macro (complex and real) and people-oriented (managerial–subjective) problems. AHP can integrate with different techniques, such as linear programming, quality function implementation, fuzzy logic, and others. The objective of this research is to identify the most relevant factors in individual energy consumption behavior towards energy sustainability and to investigate the level of importance of each factor in the Malaysian context. To fulfill this purpose, empirical research involving Malaysian professionals and energy consumption behavior experts was conducted to validate and analyze these factors in the Malaysian individual energy consumption behavior context. The purpose of this study is to identify significant elements of individual energy consumption behavior, and AHP is used to give a simple method for decision-makers to prioritize among the relevant factors. Using AHP ensures that qualitative assessments are quantified, allowing for precise comparisons and minimizing or eliminating any imbalanced scale of evaluations, imprecision, or uncertainty among pairwise comparisons [11]. Chua et al. provided a number of suggestions and proposals for conducting the study using the AHP technique, which were also used by the current study, in order to make selections among the factors and sub-factors of individual energy consumption behavior [17,18].

2.1. Analytical Hierarchy Process (AHP)

The following are the various steps of AHP:

Step 1: Define the Problem.

Energy consumption is very important for sustainability, which can be used to mitigate the challenges posed by climate change and environmental pollution. Energy consumption is dependent on individual behavior, which is invariably unpredictable for the volume of energy used. Individuals are responsible for a large share of total energy consumption, which requires a reduction in the demand for energy. Growth in population and energy-wasting behavior of the consumers inevitably leads to an increase in technological innovations and appliance efficiency.

Step 2: Identify the potential factors and sub-factors and questionnaire development.

Following that, a literature study was used to identify probable determinants and sub-factors associated with individual energy use behavior. A series of questionnaires is also being produced for each of the study's factors and sub-factors. The experts have the power to remove or add elements, as well as reorganize their hierarchies and levels.

Step 3: Evaluation of the Factors and sub-factors by Stakeholders or expert.

After evaluation of the factors and sub-factors, n number of stakeholders or experts (decision makers) from the industry, non-governmental organizations, and academic institutions determine the relevant factors. Expert selection is also an important part of the multi-criteria decision-making process.

Step 4: Identification of relevant factors and sub-factors for individual energy consumption behavior.

In this step, the factors and sub-factors of individual energy consumption behavior are identified by comparing the weight of each factor and sub-factors with the threshold value 'ã' (threshold value). The value of ã is calculated by the average of all factors' weight ãj, (average threshold value). In general, if ãj $\geq$ ã, then factor j is selected, whereas if ãj < ã, then factor j is rejected. After identification of the factors and sub-factors of individual energy consumption behavior, they are arranged in different levels and hierarchies. The

top level is called the goal where individual energy consumption behavior is placed. Under the goals lies the main factors, such as social structure, institution, education, social norms and values, and lifestyle. At the third level of the hierarchy are the sub-factors under their respective main factors. Thus, social class, gender, ethnicity, and location are placed under social structure, while the sub-factors of energy policy and energy tariff are placed under institution. Moreover, the sub-factors of environmental consciousness, ecology knowledge, and environmental concern are placed under education. Furthermore, the sub-factors of culture, spirituality, moral values, and ethics are placed under social norms and values. Lastly, the lifestyle, personal materialism, and energy efficient technology are categorized under lifestyle. The identified factors and sub-factors of individual energy consumption behavior are shown in Table A1.

Step 5: Development of a second questionnaire with relevant factors of Individual energy consumption behavior and evaluation through AHP.

Following the identification of the relevant factors and sub-factors for individual energy consumption behavior, a second set of questionnaires was developed. This time, the questionnaire only includes the factors and sub-factors of individual energy consumption behavior that have been identified. Through the analytical hierarchy method, the factors and sub-factors of individual energy consumption behavior are subjected to further evaluation. The data from experts are collected using the second set of questionnaires. The Saaty scale was used to evaluate the responses to the questions (see Table A2). The experts on individual energy consumption behavior are from the industry, non-government organizations, and academic institutions.

Step 6: Pairwise comparisons of the relevant factors using the Analytical Hierarchy Process tool.

For a paired comparison, data are collected from experts on the Saaty scale. An overall response is created using the geometric mean of the pairwise comparison values from the experts' answers. This stage intended to aggregate the respondents' knowledge in order to improve the generalizability of the results. The software used to calculate the pairwise comparison as well as all other calculations is APH software, Expert Choice version 11. The study defines its goals, identifies the causes and sub-factors of individual energy consumption behavior, and evaluates key trade-offs in a straightforward process with the support of expert decision. Expert Choice supports us in developing a decision model and determining the relative importance of the elements and sub-factors through pairwise comparisons. Expert Choice then analyzes the assessments and combines them to obtain a conclusion, as well as allowing us to see how adjusting the weighting of our criteria influences our result. Expert choice assists the study in determining the local weight of each factor and sub-factor as well as verifying for consistency utilizing the Consistency Index (CI), Random Consistency Index (RCI), and Consistency Ratio (CR) before arriving at our conclusion. The decision is acceptable if the CR is less than 0.1 [19]. Otherwise, the pairwise comparison matrix should be modified to remove the inconsistency. This step will be conducted separately for each respondent as well as for the aggregate answer. The consistency check procedure is outlined below.

2.2. Calculation of Consistency Ratio Follows the Below Three Steps

1. Find the relative weights and λ_{Max} (Eigenvalue) for each pairwise comparison matrix of order n.
2. Find the consistency index for each matrix of order n by the formula: $CI = (\lambda_{Max} - n)/(n - 1)$, where n is the matrix size and RCI can be found in Table 1 below.
3. Finally, calculate the consistency ratio using the formula: CR = CI/RCI.

Step 7: Essential factors prioritize in descending order of importance.

The next step is to synthesize the solutions for the generation of the individual energy consumption behavior measures once the normalized priority weights for each pairwise

comparison judgement matrices have been calculated. To generate the global composite priority weights of all sub-factors employed in the AHP framework, the normalized weights of the factors and sub-factors obtained in the previous step are added together with respect to all succeeding hierarchical levels.

Step 8: Formulation of Framework.

The individual energy consumption behavior index or framework is created in this step. Individual energy consumption factors and sub-factors are presented in ascending order of importance. Figure A1 illustrated the process of methodology flow of constructing individual energy consumption behavior index.

Table 1. Random consistency index value.

M	2	3	4	5	6	7	8	9	10
RI	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51

Note: Random index values for problem = 10.

3. Results

The findings mainly consist of the preliminary survey results from the experts about the individual energy consumption behavior. The data were collected from 121 experts. The framework is developed by assigning weight to the selected factors and sub-factors based on their relative importance in pairwise comparison matrices.

3.1. Identifying Factors and Sub-Factors

From a review of the literature on individual energy consumption behavior, numerous factors and sub-factors were identified. Social structure, education, institutional influences, social norms, social value, and lifestyle all play a part in influencing individual consumption patterns [13–15,18,20,21]. These factors are processed to determine the relative priority of each, thus forming the individual energy consumption behavior index.

3.2. Selection of Factors and Sub-Factors

The mean value of each factor and sub-factor is computed first, in order to select relevant factors and sub-factors. This is done by multiplying the percentage of responses in a category by the value of the category, then adding the results. A standard mean value is used as the cut-off criteria to select the relevant factors after finding the mean value of each factor and sub-factor. The average of the maximum and minimum mean values is then chosen as the cut-off criteria.

3.3. Defining and Sampling Experts

The experts' opinions were used to choose and weigh the appropriate elements and sub-factors of individual energy consumption behavior in the research study. Expert sampling, a non-probability sampling technique, was also used in the study to select experts in the fields of energy use and the environment. This is a type of purposive sampling in which the researcher selects the sampling unit based on their own knowledge. Industrial professionals, non-government experts, and institutional officials were separated into three categories. Non-government officials' information is gathered from relevant non-governmental organizations and their official websites. Personal contacts are used to collect data from industry professionals and institutions. Table A3 provides a brief summary of each expert category. The number of experts selected for each of these categories, however, varies. For example, the vast majority of experts come from the industry (n = 111). The remaining experts come from academia (n = 5) and non-governmental organizations (n = 5). As a result, 121 experts were chosen for the preliminary survey and the AHP pairwise comparison rating.

As the study is conducted in the Malaysian context, all of the experts selected are Malaysian citizens (Malaysian Nationals = 121). These experts can deliver the most reliable

information about Malaysian society, as they represent almost all three major ethnic groups in Malaysia (Malays = 74, Chinese = 29, Indian = 17, and one other minority expert, who is Thai by ethnicity and Malaysian by citizenship, other = 1). Regarding the gender allocation of the experts, 46.28% are male and 53.72% are female (Male = 56 and Female = 65). The expert's age ranges from 21 to more than 60 years. Most of the experts' ages lie in the range of 21 to 50 years, i.e., 116 experts are aged between 21 to 50 years of age, while the remaining 3 experts are older than 50 years. The majority of the experts are married, i.e., 83 experts are married, whereas 35 experts are single and 3 experts are divorced. In the current study, none of the experts are found to be separated from their spouses while conducting the questionnaire survey. For the highest education qualification, the experts can be divided in upper secondary diploma holders (n = 20), certificate/diploma holders (n = 57), Bachelor Degree holders (n = 43), and Master degree and above (n = 1). The rate of higher education is not very impressive, but it is worth noting that in the field of energy consumption and environmental issues, these experts have a minimum experience of 5 years and up to 10 years as per previous research criteria. The demographic details of the selected experts are given below in Table A4.

3.4. Data Collection through Survey Questionnaires from Experts

A questionnaire for the preliminary survey was constructed using the factors and sub-factors of individual energy consumption behavior. It was divided into two parts, with questions ranging from 1 to 9 on a scale devised by Saaty [16,17], where 1 denotes equally important and 9 denotes extremely important [14]. Five potential factors of individual energy consumption behavior were identified from the empirical literature for the first part of the questionnaire. The second section of the questionnaire contained 16 sub-factors. The questionnaire was given to a range of experts in order to get their expert opinion on the factors and sub-factors that influence individual energy consumption behavior.

3.5. Prioritization Using the Analytical Hierarchy Process (AHP)

3.5.1. Finding the Consistency Ratio

The factors influencing individual energy consumption behavior are prioritized using the AHP technique. For the factors and sub-factors, pairwise comparison judgement matrices are produced. It is necessary to find the consistency ratio before aggregating the pairwise comparison judgement matrices data in order to prioritize the factors of individual energy consumption behavior (CR). It explains how consistent the respondents were in their ranking of one dimension over the other. The results of the CR value show that the CR of each of the pairwise comparison judgement matrices is less than or equal to 0.05, which is significantly less than the rule of thumb of 0.10. This clearly demonstrates experts' consistent behavior when making comparisons. The consistency ratios' results are listed below. The consistency ratios' results are listed below. The overall consistency ratio of individual energy consumption behavior is shown in Table A5, while the consistency ratio for variables influencing individual energy consumption behavior is shown in Table A6.

3.5.2. Pairwise Comparison

Tables A7–A12 show the findings of a Pairwise Comparison Judgment Matrices (PCJM) for the total sample after determining the consistency ratio (CR).

3.5.3. Computing Normalized Weights

To obtain the global composite priority weights (GCPW) of all the sub-factors utilized in the third level of the AHP model, the normalized weights of the factors and sub-factors are added together with respect to all succeeding hierarchical levels. The complete individual energy consumption behavior model is based on the overall sample (opinions of all experts), as indicated in Table A13 below, in addition to the local and global weights (GW).

The results show that education ranks first, with a global weight of 38.5% (GW = 0.385) among all the factors influencing individual energy consumption behavior. Institution,

with a global weight of 18.5% (GW = 0.185), social values and norms, with a global weight of 15.8% (GW = 0.158), and social structure, with a global weight of 14.8% (GW = 0.148), are the next most important factors. Experts, on the other hand, assigned lifestyle the least attention and priority, with a global weight of 12.6% (GW = 0.126).

Education further consists of sub-factors, such as environmental concern, ecology knowledge, and environmental consciousness. Environmental concern ranks in first, with a global weight of 16.0% (GW = 0.16), followed by ecological knowledge with 12.9% (GW = 0.129). Furthermore, with a global weight of 9.6% (GW = 0.096), environmental consciousness is ranked third. From the overall ranking of the education factors, it is clear that education plays an essential role in energy conservation by encouraging people to educate themselves about the environment and climate change. This, in turn, will add value in terms of raising public awareness about environmental concerns. This will motivate people to be more concerned about the environment, as evidenced by the results obtained, which have been ranked first by experts among all the sub-factors of education.

Energy policy and energy tariffs are two sub-factors within the institution factor. With a global weight of 12.0% (GW = 0.12), energy policy is ranked first, followed by the energy tariff with a global weight of 6.5% (GW = 0.065). When these institutional factors are ranked, it is apparent that energy policy has the greatest impact on energy conservation when compared to energy tariffs.

Culture, spirituality, morals, and ethics are all sub-factors of social values and norms. Moral is the most important factor, with a global weight of 5.3% (GW = 0.0530), followed by culture and ethics, each with a global weight of 4.2% (GW = 0.042). Furthermore, spirituality has the least global weight of 2.1% (GW = 0.021) among all the sub-factors of social values and norms.

Sub-factors of social structure include social class, gender, ethnicity, and location. With a global weight of 5.1% (GW = 0.0510), social class is ranked first, followed by geography, gender, and ethnicity, with global weights of 4.3% (GW = 0.043), 2.9% (GW = 0.029), and 2.5% (GW = 0.025), respectively. Individual energy consumption behavior is more influenced by socioeconomic class and geography than by gender and race, according to the results. The results also imply that energy consumption in cities is higher than in rural areas, where services are more readily available.

Lifestyle is further subdivided into sub-factors, such as lifestyle choice, personal materialism, and energy-efficient technology. Energy efficient technology ranks first with a global weight of 6.4% (GW = 0.064), followed by lifestyle choice and personal materialism with global weights of 3.2% (GW = 0.032) and 3.0% (GW = 0.030), respectively.

4. Discussion

Studies have amassed a substantial body of work on energy use and conservation behavior. Numerous models and theories, including the theory of planned behavior, theory of belief, attitude, and behavior, have attempted to explain individual energy usage. Individuals are expected to modify their behavior when confronted with discrepancies in their beliefs, attitudes, and values that influence their behavior, for example in energy use. Reflecting theories mentioned in the introduction, the finding of this study demonstrated that analytical hierarchical approaches had prioritized the identified factors and sub-factors influencing the individual energy consumption behavior in the Malaysian context. This prioritization, together with the reformation of inefficient energy habits and reinforcement of routine energy behavior in favor of more efficient energy practices, will result in an energy sustainability and a greener community. There were 16 identified relevant sub-factors of individual energy consumption behavior. The sub-elements are part of the individual energy consumption behavior index's five main factors, which are: 1. social structure, 2. institution, 3. education, 4. social values and norms, and 5. lifestyle. These five main factors are combined to produce an individual energy consumption behavior index, which may be used to facilitate decision-making and contribute to Malaysia's energy conservation and sustainability.

4.1. The Outputs of AHP

The main tool used for the analysis purposes of obtaining AHP results is the expert choice software version 11. The consistency ratio was calculated before the weighting of the variables and sub-factors to ensure that the expert responses were consistent. The consistency ratio was used to assess the consistency of 121 expert judgement results. The consistency ratios show the inconsistencies in the expert data. It also aids in establishing the experts' reliability when it comes to prioritizing the factors and sub-factors that influence individual energy consumption behavior. The consistency ratio's range is determined by the size of the matrix [17]. For the current study, all of the consistency ratios were calculated according to acceptable standards and were ready for the intended analysis.

Establishment of an Individual Energy Consumption Behavior Index

The main purpose of this study was to develop a framework for individual energy consumption behavior in Malaysia that would lead to energy sustainability. To integrate all of the individual energy consumption behavior characteristics with their relative weightings, the analytical hierarchy process was used. The weighting system for individual energy consumption behavior was a key component for constructing an index by aggregating the scores of all the individual factors and sub-factors.

Education was given the highest priority among all other factors, according to the empirical result of the individual energy consumption behavior index. A study in South Africa found that households have adequate knowledge about energy efficiency and that this has a significant impact on the environment [21]. Experts agree that the public has to be educated about climate change and the environment in order to conserve energy. In a focus group interview, a study in Malaysia highlighted that in the past, school education lacked education programs that would allow young to learn and appreciate the environmental impact of mankind's activities [22]. However, the participants acknowledged that certain education programs are now being implemented in schools to teach youngsters how to behave in an environmentally sustainable manner, such as emphasizing meaningful resource consumption and garbage recycling. This indicates that educational institutions are concerned about environmental issues. As a result, educational institutions implement programs that provide students with environmental knowledge and help them develop a sense of environmental consciousness [23]. Environmental concerns, knowledge, and awareness of energy efficiency environmental issues should all be associated with education. However, a high level of education does not ensure environmentally responsible conduct [24]. Furthermore, the information is more likely to inspire sustainable energy consumption behavior when it aligns with people's core values. Therefore, the experts in the current study want the educational system to be concerned about the environment, and they have incorporated courses or programs to disseminate environmental knowledge. These types of programs would raise environmental awareness among students at a young age, helping Malaysia's energy sustainability.

The empirical result of the individual energy consumption behavior index show that institutions are assigned the second highest priority. In Malaysia, the Economic Planning Unit (EPU) is in charge of establishing, regulating, and implementing policies, rules, laws, programs, and projects to enhance the economy, as well as coordinating the operations of other energy-related institutional entities. Furthermore, the Ministries of Energy, Green Technology, and Water are in charge of policy formulation and service regulation for the energy, green technology, and water sectors, respectively; they facilitate and regulate their growth. Finally, the Energy Commission (EC) is in charge of the Ministry of Energy's regulatory functions [25]. The institution is in responsible to maintain social order and controlling individual behavior and in charge of formulating energy policies and enforcing energy pricing. Environmental disasters will occur, however, if society uses these energy supplies irresponsibly. As a result, the government sometimes raises energy tariffs to control the energy-wastage behavior of the masses. However, these practices are to fault for inflation and the stagnation of the economy. Tariffs are based on energy consumption

and are charged according to the amount used. Rebates play an important role in helping to promote energy conservation, as rebates in the form of tax incentives provide both consumers and companies with a wide range of incentives, as well as opportunities to change their energy consumption patterns [26]. Therefore, the government should place a greater emphasis on energy policy in order to urge the public to save energy in order to ensure a steady supply of energy resources.

After education and institution, social values and norms are given third priority in the individual energy consumption behavior index. Moral values, ethics, culture, and spirituality all represent social values and norms. Based on the findings, moral values ranked first among the other sub-factors of social values and norms. According to experts, moral values have a substantial impact on energy consumption behavior and play a key role in exerting social pressure on people to reduce their energy consumption in order to improve environmental sustainability. Previous research endorsed the idea that moral values are effective motivators for environmentally sustainable behavior [27]. Similarly, according to the norm-activation model, moral values and responsibilities influence prosocial behavior [28]. In terms of moral values, the individual must be aware that their actions and behaviors have an impact on others and the environment. If people are willing to embrace the reality that energy consumption has a negative impact, they must feel a stronger obligation to save energy. According to experts, ethics and culture rank second among the other sub-factors of social values and norms. By definition, ethics are the principles that govern consumer behavior. The greater the value placed on ethics, the more a person will endeavor to behave in a morally acceptable manner [27,28]. Specific behaviors lead to a person adopting certain behaviors that are consistent and recurring in accordance with the consumer's values [29]. As a result, experts believe that the importance of ethics should be recognized as a variable that has the potential and aptitude to guide individual behavior toward energy conservation and sustainability. In contrast, a study on the influence of social norms on consumer behavior suggest that while social norms have a steady effect on approved behavior across time and cultures, their impact on disapproved behavior has increased with time and is stronger in survival cultures. Social norms are enhanced by information identifying specific organizations or close group members, as well as by the presence of monetary costs [30].

On the other hand, culture is described as a person's way of life and how they make decisions. People who live in various environments have varying demands and requirements, and hence, have varying cultures. Through the values, beliefs, and customs that prevail in that community, an individual is most influenced by the people around them and their surroundings. Culture is, in fact, the whole total of an individual's ideas, behaviors, and knowledge in a specific society. Culture can be taught through social interactions with others from similar societies, and it can contribute to the development of identities and the orientation of daily activities [31,32]. It is culture that is employed as a lens through which people can view the world and make judgments. A person's attraction to various things and activities is influenced by their culture. However, according to the literature, people's behavior is extremely difficult to change due to deeply ingrained social values, habits, and cultural values [29]. According to the study, culture advances as a result of harnessing more energy, although it should be noted that we are not to conclude that people can choose to vary the technology they use to harness energy and, therefore, their culture [33,34]. Culture has a long-term impact on individual behavior, and many researchers believe there is a positive association between energy conservation and culture. As a result, the panel of experts recommends focusing on the cultural aspect of individual energy consumption behavior in order to reduce energy consumption [33]. According to social psychologists, people's behavior is influenced by the behavior of those around them.

Spirituality, which the panel of experts ranked third among the sub-factors of social values and norms, is frequently associated with religiosity and is seen as the best alternative for possible energy sustainability interventions. According to previous studies, it supports people in abstaining from immoral acts and practices. On the other hand, it does support

an individual's good conduct [32]. When one has a higher level of spirituality, there is a stronger level of commitment to moral commitments and ethical responsibilities [33]. Spirituality and religiosity should not be confounded since spirituality is an expression of oneself to other people and nature, but religiosity is the association of having specific principles, following specific intuition, and having specific practices [34]. Spiritual people are more likely to care for the environment through sustainable consumption because of their connection to nature. Since spirituality includes the concept of natural sustainability, the panel of experts placed more emphasis on spirituality in terms of energy conservation and sustainability than in previous studies. Spirituality already has the power to convince people to use less energy and conserve resources for a better future, a healthy ecosystem, and environmental stability.

The empirical result of the individual energy consumption behavior index demonstrates that, among the other factors, social structure is ranked fourth. Social class, gender, ethnicity, and location all contribute to the social structure. From the results, it is shown that social class ranks first among the other sub-factors of social structure. The consumer's income level is generally represented by the class in the current study. The higher the social class and financial level, the more energy is consumed. As a result, consumers from various socioeconomic classes and income levels used different amounts of energy. Poor households and consumers, for example, utilize less energy, but high-income and wealthy individuals consume a huge amount. Previous research also shows that wealthy consumers spend more on energy sources than poor households, which experience energy poverty from time to time due to a lack of resources [35,36]. Furthermore, a range of other factors contribute to energy poverty, including low income, non-standard housing with inadequate or poor quality insulation, and price hikes [37]. Class is also associated with employment status, household size, and education, all of which might restrict energy use. This issue has been raised in a number of studies. Consumer income and social class are two of the most significant predictors of energy use and conservation. The majority of the studies showed an association between income and energy consumption behavior. Some studies demonstrate weak relationships, while others show strong relationships that are robust and positive [37–42]. In South Africa, middle- and upper-income classes consume the most electrical energy [21]. In agreement with this finding is another study that indicates that individuals within the same social class tend to accommodate similar behavioral norms [22]. The current study's expert panel placed a high value on socioeconomic status. The number of energy consumers in the upper class may be lower, and they are more likely to be skeptical about energy conservation. As a result, there are lower odds of persuading high-income people to reduce their energy consumption. However, concentrating energy conservation initiatives on middle-income individuals has a high possibility of success. Moreover, lower income or class consumers are already struggling with energy poverty and low income.

A previous study indicated that location has a significant influence on the consumption patterns of residents, notably influencing energy consumption behavior in households. Location comes in second place among all the other social structure sub-factors. The precise location of each individual energy consumer is important. To save time and money, consumers who live near public transportation, schools, universities, and employment centers avoid driving their cars. This step contributes to reducing the amount of energy used. Consumers who reside in densely packed developments with limited transportation options have a better chance of getting around for less money than those who live in sprawling areas with few options [43]. Given the pressing need to minimize energy consumption and greenhouse gas emissions, having a home that is conveniently accessible by public transit, as well as easy access to employment, schools, and institutions, is quite advantageous.

Gender is ranked third among all of the social structure's sub-factors. Gender disparities in energy consumption and conservation have no impact. In a study, women report stronger environmental attitudes and behaviors than men across age and across 14 countries. However, as a single variable, the effect of gender on proenvironmental

behavior was consistently stronger than on environmental attitudes [26,37]. Gender would have only a minor impact on energy consumption if it exists at all. Many factors based on gender disparities, such as socioeconomic conditions and lifestyles, have a significant impact on both genders' energy consumption. In research of energy consumption behavior, gender is an important variable. Nevertheless, there are differences between the male and female genders in terms of energy consumption because they are not homogeneous and consistent. As a result, when it comes to understanding the role of both men and women in energy consumption and concern for environmental degradation and climate change, the panel of experts ranks it third based on their previous experience with gender differences in energy consumption.

Ethnicity is ranked fourth among all the sub-factors in the ranking of social structure sub-factors. Throughout history, people from many cultures have established ethnic groups, which are sub-cultures. These ethnic groups differ in many ways, including consumption patterns, and their actions have a significant impact on them. The models imply that households led by racial/ethnic minorities have lower behavioral energy intensity [38]. However, another study claims that an ethnic group's self-identity motivates people to perform certain things and determines their consumption behavior. Consumers from similar ethnic groups consume at similar levels, determining the extent of impact on their attitudes and behaviors [39]. Conversely, ethnicity had no impact on energy consumption in the current study, according to a panel of experts in Malaysia.

The empirical result of the individual energy consumption behavior index demonstrates that, among other factors, lifestyle is given the last priority. The lifestyle is represented by personal materialism, energy-efficient technology, and lifestyle choice. According to the findings, energy-efficient technology ranks first among the other lifestyle sub-factors, followed by lifestyle choices and personal materialism, in that order. For two reasons, people prefer to invest in energy-efficient technologies. The first motivation is to modify their energy-wasting practices, and the second reason is to address climate change and environmental degradation problems by adopting green energy. Surprisingly, this pattern can be found across all socioeconomic levels. People tend to embrace more energy-efficient devices as their income levels rise. In comparison to low-income people, middle-income people are usually more interested in adopting energy-efficient technology since they can afford it. The highest-income people, on the other hand, are more interested in commercial investment opportunities in energy-efficient technologies than in conserving energy [40,41]. It is also possible that employing energy-efficient technologies will provide economic benefits. By using energy-efficient technologies, the individual reaps the benefits in the form of lower energy bills and, in some instances, could benefit from shifting to green energy. In addition, using energy-efficient technologies and becoming green helps to reduce carbon emissions, which benefits the environment.

Past studies have linked human activities with greenhouse gas emissions that cause global warming and climate change [2]. Carbon dioxide is the most important and longest-lived gas in the atmosphere, and it is the one that causes global warming. As a result, addressing climate change and decarbonizing the economy necessitates a significant investment in energy-efficient technologies [42]. It is also worth noting that household and individual energy consumption are the main contributors to greenhouse emissions, with European families and individuals accounting for a quarter of the total energy consumption [43]. Considering the significance of energy-efficient technologies, the panel of experts considers energy-efficient technologies to be the most important sub-factor of lifestyle out of all other sub-factors.

A person's lifestyle is defined by the way a person spends their lives and is reflected by their consumption behavior. The external environment, individual factors, and consumer choices, to name a few, all have an impact on consumer lifestyle. Furthermore, cultural and social factors influence an individual's energy consumption. A lifestyle is a consumption pattern influenced by decisions made at different points in one's life, such as choosing a job or profession, living location, raising a family, equipment use, and energy consumption.

Thus, a person's lifestyle and energy consumption enable them to acquire and utilize specific appliances [44]. However, in the current study, according to the panel of experts, the lifestyle sub-factor has no significant role in the consumption of energy, and therefore, it is ranked as the second most important sub-factor of the lifestyle category.

Personal materialism is ranked as the least important sub-factor in the ranking of lifestyle sub-factors by the panel of experts. The ownership and possession of tangible items is defined as personal materialism. Material possessions have a negative impact on the environment because it creates a demand for more natural resources. Overconsumption and an excess of material possessions are negatively associated with caring for oneself, society, and nature. The practice of basing one's life standard on the availability of material goods harms the environment. This notion that materialism and the environment are negatively associated has also been addressed in early studies [42]. People who are materialistic are less concerned about natural resource shortages, climate change, and pollution [45]. However, according to the panel of experts in the current study, personal materialism has no influence on energy usage in Malaysia.

Studies have amassed a substantial body of work on energy use and conservation behavior. Numerous models and theories, including the theory of planned behavior, theory of belief, attitude, and behavior, have attempted to explain individual energy usage. Individuals are expected to modify their behavior when confronted with discrepancies in their beliefs, attitudes, and values that influence their behavior, for example in energy use. Reflecting theories mentioned in introduction, the finding of this study demonstrated that analytical hierarchical approaches had prioritized the identified factors and sub-factors influencing the individual energy consumption behavior in the Malaysian context. This prioritization, together with the reformation of inefficient energy habits and reinforcement of routine energy behavior in favor of more efficient energy practices, will result in energy sustainability and a greener community. The goal of this research was to come with an effective and useful individual energy consumption behavior model. The views of experts on the understanding of the model, its precision, applicability, and feasibility have shown a very high degree of consensus in favor of the developed model. Individual energy consumption behavior is the outcome of a complex interaction of individual elements, including education, institutions, societal values and norms, social structure, and lifestyle. The model is a positive contribution to the area of individual energy consumption behavior in the context of Malaysia. Other disciplines should complement these model approaches in order to achieve broader and more diverse energy sustainability. Interdisciplinary collaboration could contribute to developing the most significant intervention for changing consumer behavior at the individual level in terms of energy savings and social acceptance. The comprehensive set of factors identified were at the heart of the energy sector's desired interventions. The developed model is capable of ranking individual energy consumption behavior features and obtaining a single comparable value, that is, it is more likely to optimize energy consumption decision support systems.

4.2. Strengths and Limitations of the Study

The current study passed through a number of stages during its entire research journey. The study focuses on the concept of individual energy consumption behavior in Malaysia as it relates to energy sustainability. There was no existing research framework that included the different dimensions of individual energy consumption behavior that the study could identify. The result from this study would be useful to guide decision makers in addressing individual energy consumption behavior issues in Malaysia. In light of this situation, the study was conducted with three main and most significant objectives. The objectives of the study were, firstly, accomplished by identifying the factors influencing individual energy consumption behavior from the previous literature. The literature was critically analyzed in order to generate a strong foundation on which to develop a theoretical framework for the study and proceed to the empirical phase. Secondly, the factors and sub-factors were successfully prioritized using the fuzzy-Delphi method and the involvement of the

experts. Finally, at the end of this study, the individual energy consumption behavior model was developed, with education ranked first among the main factors influencing individual energy consumption behavior, followed by the institution, social values and norms, social structure, and lifestyle. The theoretical framework was developed after a thorough review of the literature and consultation with the study's stakeholders. This framework is capable of ranking the individual energy consumption behavior factors and sub-factors and helps in obtaining a single comparable value, which is more likely to optimize energy sustainability in Malaysia. The model is simple and straightforward to implement for energy conservation and sustainability. The framework will be useful to implement or design an intervention on smart energy consumption among Malaysians in order to ensure energy sustainability, and hence, reduce climate change and environmental degradation. Having established a framework, further research can be conducted to explore in-depth how this factor contributes to energy sustainability in Malaysia and elsewhere.

However, this study has a shortcoming: the sampling method utilized was purposive sampling, which is non-probability sampling, and thus, it cannot be generalized to the entire population. The sample size, on the other hand, was large enough to represent experts with particular experience and expertise. Furthermore, the number of experts was determined in accordance with the literature: according to Saaty, for homogeneous groups of experts, 5 to 20 experts are necessary. Being a suitable AHP panelist necessitates the presence of a highly skilled expert. In addition, several studies suggest that experts from other fields of expertise be included in order to gather unbiased and diverse knowledge [21]. The current study includes 121 experts with a wide range of backgrounds and expertise.

5. Conclusions

Expert opinions on the framework's understanding, precision, applicability, and practicality have indicated a high level of agreement in favor of the established framework. In the setting of Malaysia, the framework provides a strong contribution to the field of individual energy consumption behavior. In this study, education was ranked first in this individual energy consumption behavioral measure, followed by institutions, social values and norms, social structure, and finally lifestyle. In energy consumption, consumers participate actively in the co-creation of value in the energy sector. With consumers as co-creators of value, the service provider's function shifts to that of facilitator, supporter, organizer, framework supplier, co-constructor, co-performer, and co-creator of value. The energy provider's strategic focus switches from figuring out how to help customers get more out of its direct service activities to figuring out how to enable, support, and improve customers' everyday routines, processes, and experiences in meaningful ways. Through the resources they use, energy providers can, thus, contribute to the value creation of their clients. The energy sector's desired interventions were centered on the full set of issues identified from this study. The developed framework is capable of ranking individual energy consumption behaviors and producing a single comparable value, making energy consumption decision support systems more likely to optimize. Furthermore, the established approach is straightforward and simple enough to be easily implemented in practice, with numerous benefits for Malaysia's energy sustainability.

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Institutional Review Board Statement: The research ethics protocol, instrument and data collection plan developed in the study underwent institutional review via the Department of Management and Humanities research proposal defence committee of Universiti Teknologi Petronas, Malaysia as well as the post graduate research progress committee.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study is available on request from the corresponding author. The data is not publicly available due to confidentiality.

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Conflicts of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Appendix A

Table A1. Identified factors and sub-factors of individual energy consumption behavior from the literature review.

Goal	Factor	Sub-Factor
Individual energy consumption behavior	Social culture	Class Gender Ethnicity Location
	Institution	Energy Policy Energy Tariff
	Education	Environmental Consciousness Ecology Knowledge Environmental Concern
	Social Norms and Values	Culture Spirituality Moral Values Ethics
	Lifestyle	Lifestyle Personal Materialism Energy efficient technology

Table A2. Scoring scale for factor comparison.

Score		Description
1	Equal importance	The specified criteria contribute equally to the objective
3	Weakly Importance	A criterion is slightly favored compared with the other
5	Essentially Importance	A criterion clearly dominates the other in importance
7	Very Strongly Importance	A criterion is strongly favored compared with the other
9	Absolutely Importance	A criterion is unquestionably more important than the other
2,4,6,8	Intermediate Values	When a compromise is made between two adjacent judgments

Table A3. Category of expert.

Expert Group	Stakeholders	Experience	No of Experts
Industrial Professionals	Professionals who work in energy sector of Malaysia	5–10 years of experience in in industry	111
Experts from Non-Governmental organizations	People who work in/on energy consumption and conservation, climate change, and environmental issues	5–10 years of experience in NGOs	5
Institutional Officials	Experts from academia	Individuals working at least 5–10 years on energy, climate, and environmental conservation projects.	5
Total number of experts			121

Table A4. Demographic details of the experts.

Expert's Demographic Details	n (%)
Nationality	
Malaysian	121 (100)
Ethnicity	
Malay	74 (61.2)
Chinese	29 (23.9)
Indian	17 (14.1)
Others	1 (0.8)
Gender	
Male	56 (46.3)
Female	65 (53.7)
Age (years old)	
21–30	35 (28.9)
31–40	67 (55.4)
41–50	16 (13.2)
51–60	1 (0.8)
>60	2 (1.7)
Marital Status	
Single	35 (28.9)
Married	83 (68.6)
Divorced	3 (2.5)
Highest Academic Qualification	
Upper secondary	20 (16.5)
Certificate/Diploma	57 (47.1)
Bachelor degree	43 (35.3)
Master degree and above	1 (0.8)

Table A5. Consistency ratio for individual energy consumption behavior.

	Goal	Consistency Ratio
1	Individual energy consumption behavior	0.02

Table A6. Consistency ratio for factors of individual energy consumption behavior.

	Factors	Consistency Ratio
1	Social structure	0.01
2	Institution	0.00
3	Education	0.09
4	Social Values and Norms	0.00
5	Lifestyle	0.00

Table A7. Pairwise comparison of individual energy consumption behavior factors.

	Social Structure	Institution	Education	Social Values and Norms	Lifestyle
Social Structure	0.000				
Institution	1.10326	0.000			
Education	2.39358	1.62588	0.000		
Social Values and Norms	1.3286	1.24874	3.64378	0.000	
Lifestyle	1.01838	1.50535	2.75124	1.52855	0.000
Inconsistency = 0.02					

Table A8. Pairwise comparison of the sub-factor of social structure.

	Social Class	Gender	Ethnicity	Location
Social class	0.000			
Gender	1.94237	0.000		
Ethnicity	1.71409	1.50023	0.000	
Location	1.33858	1.79429	1.69411	0.000
Inconsistency = 0.000				

Table A9. Pairwise comparison of the sub-factor of institution.

	Energy Policy	Energy Tariff
Energy Policy	0.000	
Energy Tariff	1.85521	0.000
Inconsistency = 0.000		

Table A10. Pairwise comparison of the sub-factor of education.

	Environmental Consciousness	Ecology Knowledge	Environmental Concern
Environmental Consciousness	0.000		
Ecology Knowledge	1.01186	0.000	
Environmental Concern	2.2444	1.09076	0.000
Inconsistency = 0.09			

Table A11. Pairwise comparison of the sub-factor of social values and norms.

	Culture	Spirituality	Moral	Ethics
Culture	0.000			
Spirituality	2.05342	0.000		
Moral	1.44106	2.42413	0.000	
Ethics	1.09538	2.00804	1.16936	0.000
Inconsistency = 0.09				

Table A12. Pairwise comparison of the sub-factor of lifestyle.

	Choice of Lifestyle	Personal Materialism	Energy Efficient Technology
Choice of Lifestyle	0.000		
Personal Materialism	1.00697	0.000	
Energy efficient Technology	1.92421	2.24904	0.000
Inconsistency = 0.00			

Table A13. Composite results of weight (local/global) and ranking.

Goal	Factors	Global Priority Weights	Ranking	Sub-Factors	Local Priority Weights	Global Priority Weights	Ranking of Sub-Factors under its Main Factor	Ranking of Sub-Factors among Other Sub-Factors
Individual Energy	**Social Structure**	0.148	4	Social class	0.347	0.051	1	8
				Gender	0.194	0.029	3	14
				Ethnicity	0.166	0.025	4	15
				Location	0.293	0.043	2	9
	Institution	0.185	2	Energy Policy	0.650	0.120	1	3
				Energy Tariff	0.350	0.065	2	5
	Education	0.385	1	Environmental Consciousness	0.250	0.096	3	4
				Ecology Knowledge	0.335	0.129	2	2
				Environmental concern	0.415	0.160	1	1
	Social Values and Norms	0.158	3	Culture	0.265	0.042	2	10
				Spirituality	0.133	0.021	3	16
				Moral	0.337	0.053	1	7
				Ethics	0.265	0.042	2	11
	Lifestyle	0.126	5	Choice of Lifestyle	0.251	0.032	2	12
				Personal Materialism	0.239	0.030	3	13
				Energy Efficient Technology	0.510	0.064	1	6

Appendix B

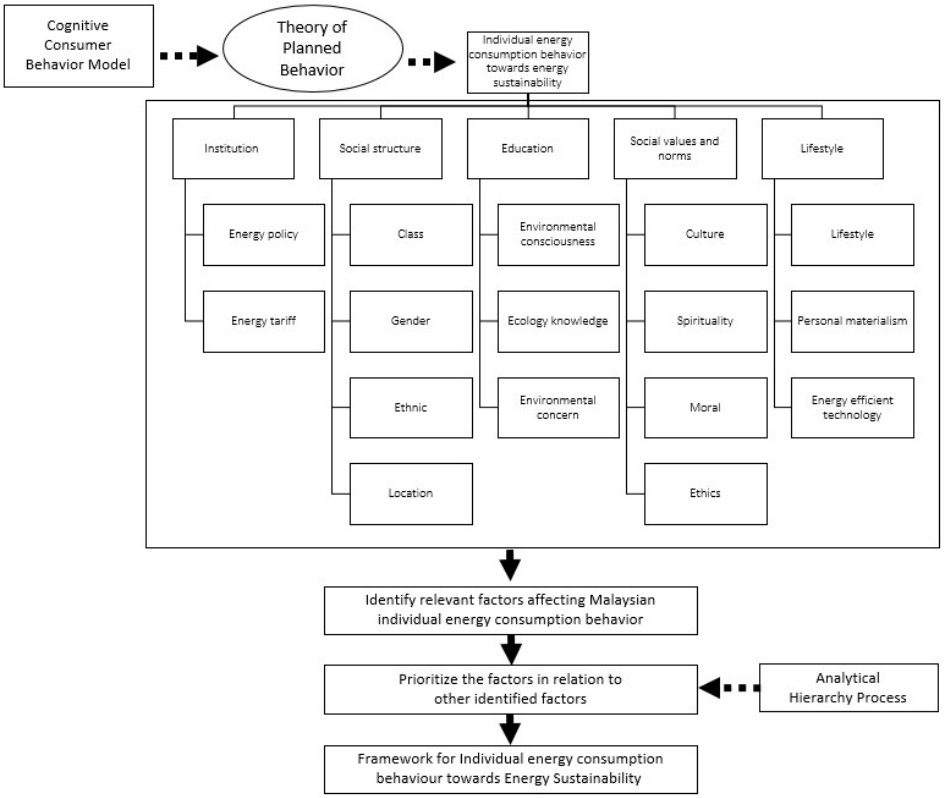

Figure A1. Conceptual framework of the study.

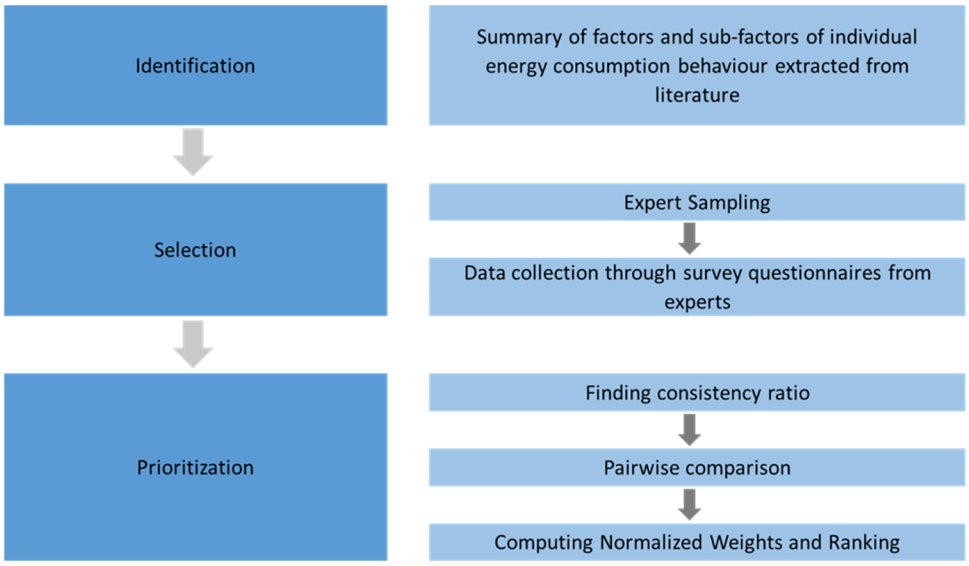

Figure A2. Process of the methodology flow of constructing an individual energy consumption behavior index.

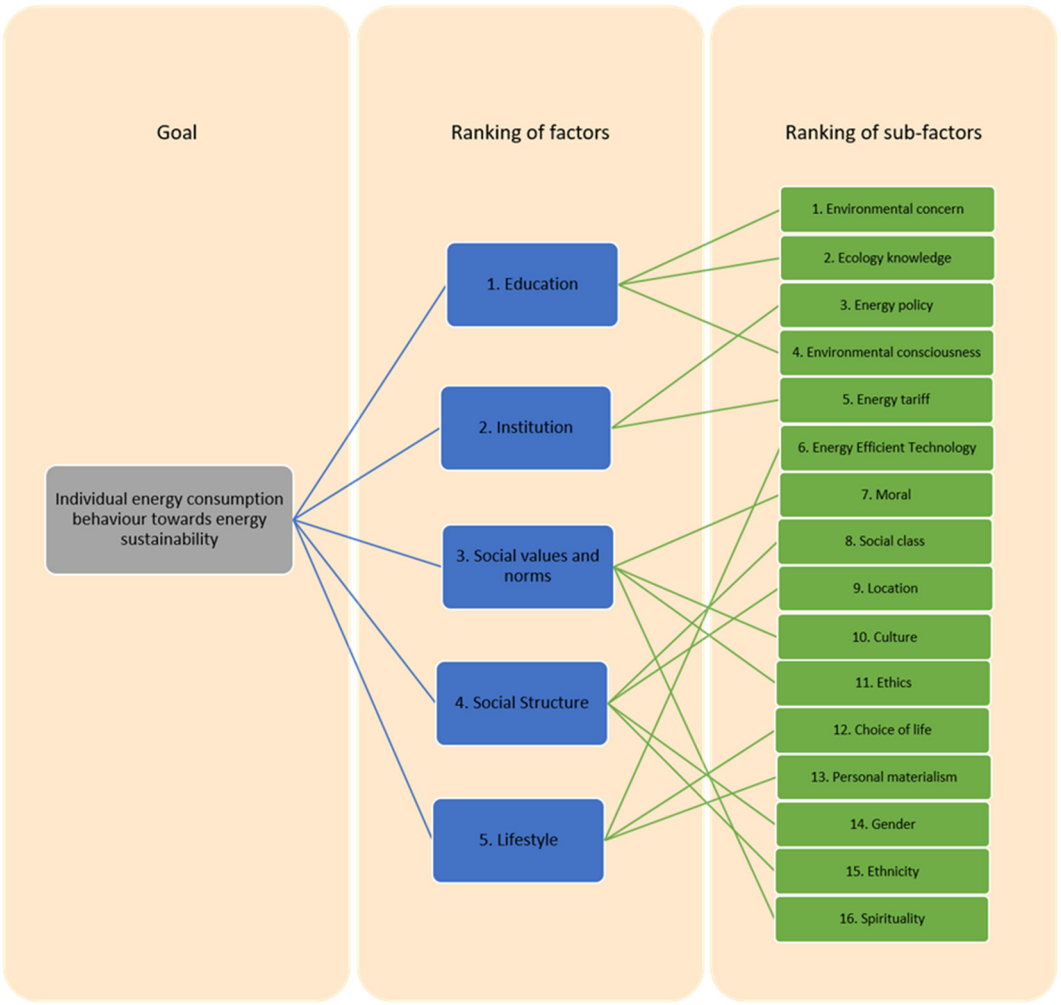

Figure A3. Framework of individual energy consumption behavior towards energy sustainability in Malaysia.

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