Assessing Energy Consumption Attitude, Efficiency, and Behavior among University Students: A Case Study from MUST University, Malaysia

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تقييم موقف استهلاك الطاقة، الكفاءة، والسلوك بين طلاب الجامعات: دراسة حالة من جامعة MUST في ماليزيا

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Abstract:

Energy is an invaluable resource that is critical for the advancement of life, economic processes, and society as a whole. The aim of this research is to ascertain the attitudes and behaviors surrounding energy consumption and energy efficiency among the students at MUST University. A total of 199 students from MUST University in Malaysia participated in this study. It was found that the majority of students exhibited a keen interest in energy consumption; however, their attitudes and behaviors were more closely associated with environmental concerns. Surprisingly, 50.8% of the students displayed limited attention towards electricity consumption, despite the fact that many of them were pursuing courses pertaining to the environment and energy matters. As for energy efficiency, the findings indicated that a considerable portion of the students (48.7%) adopted a moderate attitude towards its significance. Furthermore, a significant majority of students (62.3%) expressed approval towards the energy efficiency measures implemented by the university. Consequently, it is highly recommended for the university to actively involve students in the decision-making process, with the aim of reducing electricity consumption and enhancing overall efficiency. By actively engaging students in the decision-making process, the university can tap into their knowledge and perspectives, thereby fostering a sense of ownership and responsibility. Integrating student opinions and ideas into energy-related initiatives will not only enhance energy efficiency measures, but also promote a culture of sustainability on campus. This study provides valuable insights for MUST University and other educational institutions regarding the importance of involving students in energy-related decision-making processes. In conclusion, this research sheds light on the energy consumption attitudes, energy efficiency attitudes, and behaviors among students at MUST University. The findings highlight the need for the university to actively involve students in energy-related decision making, in order to promote energy efficiency and sustainability.

الملخص

الطاقة هي مورد لا تقدر بثمن وحيوي لتقدم الحياة والعمليات الاقتصادية والمجتمع بأكمله. هدف هذا البحث هو التحقق من المواقف والسلوكيات المتعلقة باستهلاك الطاقة وكفاءة الطاقة بين طلاب جامعة العلوم والتكنولوجيا الماليزية. شارك في هذه الدراسة ما مجموعه 199 طالبًا من جامعة العلوم والتكنولوجيا الماليزية. تبين أن غالبية الطلاب يبدون اهتمامًا كبيرًا باستهلاك الطاقة. ومع ذلك، كانت مواقفهم وسلوكهم أكثر ارتباطًا بالقلق بشأن البيئة. بشكل مفاجئ، أظهرت 50.7 % من الطلاب اهتمامًا محدودًا بالاستهلاك الكهربائي، على الرغم من أن العديد منهم يتابعون دروسًا تتعلق بالبيئة وشؤون الطاقة. أما بالنسبة لكفاءة الطاقة، فقد أشارت النتائج إلى أن جزءًا كبيرًا من الطلاب بنسبة (48.7 %) اعتمدوا موقفًا متوسطًا تجاه أهميتها. علاوة على ذلك، أعرب غالبية كبيرة من الطلاب بنسبة (62.3 %) عن تأييدهم لإجراءات كفاءة الطاقة التي تنفذها الجامعة. ونتيجة لذلك، يوصى بشدة بضرورة مشاركة طلاب الجامعة بنشاط في عملية اتخاذ القرار، بهدف تقليل استهلاك الكهرباء وتعزيز الكفاءة العامة. من خلال مشاركة الطلاب بنشاط في عملية اتخاذ القرار، يمكن للجامعة الاستفادة من معرفتهم ومنظوراتهم، وبالتالي تعزيز شعورهم بالملكية والمسؤولية. سيعزز دمج آراء الطلاب وأفكارهم في المبادرات المرتبطة بالطاقة ليس فقط تدابير كفاءة الطاقة، ولكن أيضًا تعزيز ثقافة الاستدامة في الحرم الجامعي. توفر هذه الدراسة رؤى قيمة لجامعة العلوم والتكنولوجيا الماليزية والمؤسسات التعليمية الأخرى بشأن أهمية مشاركة الطلاب في عمليات اتخاذ القرار المتعلقة بالطاقة. في الختام، يسلط هذا البحث الضوء على المواقف المتعلقة باستهلاك الطاقة ومواقف كفاءة الطاقة والسلوكيات بين الطلاب في جامعة العلوم والتكنولوجيا الماليزية. تسلط النتائج الضوء على ضرورة مشاركة الطلاب بنشاط في صناعة القرارات المتعلقة بالطاقة من أجل تعزيز كفاءة الطاقة والاستدامة.

الكلمات المفتاحية: موقف استهلاك الطاقة، موقف كفاءة الطاقة، سلوك الطلاب.

Introduction

Energy consumption is directly related to living standards and, therefore, to the gross domestic product (gdp) per capita, as indicated by Guo [1] for the industrialized countries. in the same way, it has been observed that in these countries the lifestyles and their social relations are highly linked to the most advanced technologies, while in the developing countries there are low consumption of energy linked mainly to a wide variety of lifestyles and cultures. for his part, find that above a threshold of per capita consumption of energy social relations progress and that below that threshold social conflicts are present and cannot be controlled through political processes. however, the thresholds that clarification are not clearly defined. but the high consumption of energy is also linked to the deterioration of the environment. in other words, an increase in the consumption of energy by society can have negative impacts on the ecosystems and on the health of the individuals because, at present, the generation of energy is based mainly on fossil fuels. The prevailing economic system has not been able to solve this problem efficiently, which is why many authors point out that it would be necessary for the countries to intervene to create laws, better regulate the production and supply of electricity or raise awareness among individuals. in order to encourage the efficient use of the resource and, at the same time, promote an impulse towards the use of a technology more friendly to the environment [2].

The assessment of energy consumption attitudes, efficiency, and behavior among university students at MUST University, Malaysia, reveals critical insights into how young adults engage with energy use in their daily lives. The findings indicate a growing awareness of energy efficiency among students, correlated with their educational background and exposure to sustainability initiatives on campus. However, despite this awareness, there remains a notable gap between knowledge and action, as many students exhibit behaviors that do not align with energy-saving practices.

Energy is a resource of vital importance for the development of life, economic processes and society. All forms of life, all the movements and changes that take place in nature require energy, in such a way that it constitutes a resource without which life and the development of societies would cease to exist [3]. From the point of view of elementary physics, energy is defined as everything that can be converted into mechanical work. In this sense, two types of energy are identical: the flow and reserve. The energy of flow is characterized by its constant renewal as is the case of solar radiation, wind and water currents. Reserving energy is associated with the energy existing in the earth in limited quantities such as coal, oil, natural gas and uranium, to name a few. Likewise, it is usually classified as primary and secondary energy; Primary is any form of energy available in nature before it is converted or transformed. This energy is contained in crude fuels, in the form of solar, wind, geothermal energy and others that constitute an entrance to the system [4]. The secondary, meanwhile, is one that is not directly usable or that must be transformed, such as electricity [5].

Although energy is diffused in nature in very different ways, human beings have faced the difficulty of exploiting it for their own benefit and in favor of the development of their societies. However, in their desire to dominate energy, societies have used excessive natural resources such as wood, coal and oil, among other energy sources. The problem is that these energy sources are finite and have pernicious effects on human beings and other forms of life since, emitting carbon dioxide (CO_2), they are highly polluting to the environment. In recent years, concerns about the deterioration of the environment have led to research that is based on different theories and methodologies to study the phenomenon and its consequences on human beings and societies. Attitudes are defined from the perspective of social psychology as "global and relatively stable evaluations that people make about other people, ideas or things that are technically called attitudinal objects. Attitudes are organized mentally according to what has been termed as tripartite conception of attitudes ". This concept consists of following:

1- Cognitive component.
2. Affective component.
3. Behavioral component.

Problem Statement

Energy use behavior is one of the important ingredients for energy consumption. This statement supported [6], who mentions that human behavior is an essential ingredient in energy conservation activities, approximately up to (10) percent of energy cost can be saved if building users can be persuaded to become more energy conserving [7]. A study carried out. Revealed the similar result, which shows that (5-10) percent of energy savings can be obtained by improving energy use behavior. Furthermore, another study conducted [8] revealed that (10) percent of electricity reduction could be easily achieved through the process of improving energy-use behavior.

Figure 1 shows how the electricity consumption has increased rapidly in Malaysia during the last decade from 2004 to 2013. Many experts now consider behavior as the primary lens through which to study energy efficiency [9]. Therefore, the most effective way to reduce the negative effect of higher energy consumption and greenhouse gas emissions is to consider energy conservation behavior.
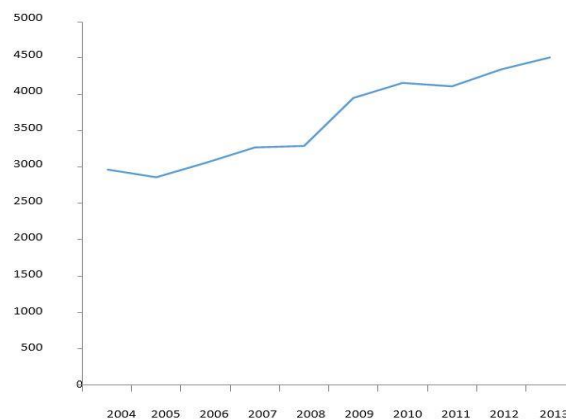

Figure 1: Electric power consumption (kWh capita) – Malaysia.

Nevertheless, discussions based on empirical knowledge about what kind of attitude rising should be done have not been done. Action plan theory is rich in suggesting the above problem. This theory is a model concerning behavioral intention, assuming attitudes toward behavior, subjective norms, and feasibility evaluation as a predecessor. The attitude is an evaluation of whether or not the behavior is preferable to an individual, and it is said that the more the attitude it has, the higher the intention of the action. The subjective norm is an evaluation on social pressures such as whether or not it is expected from the surroundings to take such behavior, and the greater the social expectation for behavior, the greater the intention of action. Evaluation of feasibility is an evaluation on whether it is easy or difficult to execute an action by individual's will, and it is an evaluation on the internal factor (i.e., effectiveness) as to whether or not he/she has the ability to execute [10].

Table 1: Analyzed data for Malaysia [2].

| Total (In CO_2 equivalents)		Methane (In CO_2 equivalents)		CO_2	
Per capita (t)	Total (mt)	Per capita (t)	Total (mt)	Per capita (t)	Total (mt)
8.04	282.31	1.06	37.18	66.98	245.14

To visualize the annual change in total final energy consumption by sector and scenario from 2000 to 2030, you can create a line graph or bar chart. This would typically include sectors such as residential, commercial, industrial, and transportation, as well as different scenarios (e.g., business-as-usual, aggressive policy changes, renewable energy adoption).
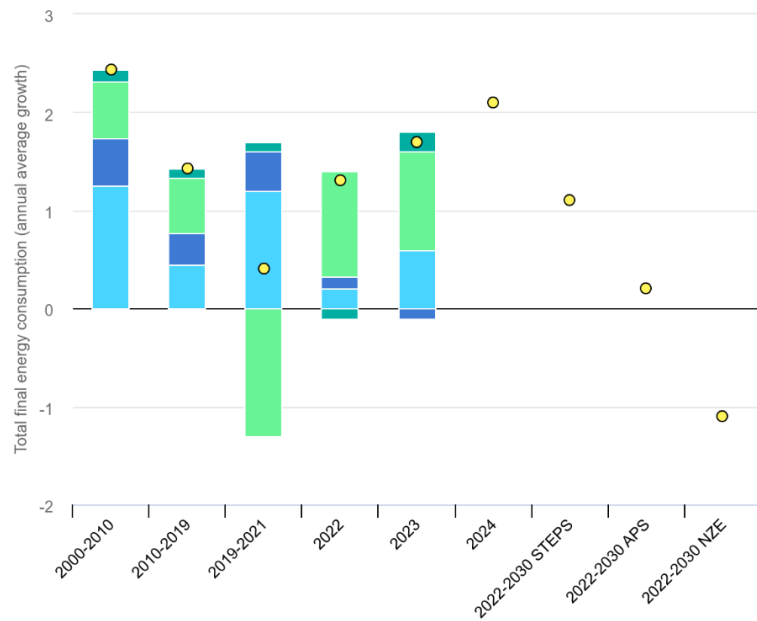
Figure 2. Annual change in total final energy consumption, by sector and scenario, 2000-2030 [11].

Typical Trends for the considered year of the study are illustrated in Figure 3.
- **2000-2010:** Generally, energy consumption in transportation saw a steady increase due to rising vehicle ownership and economic growth.
- **2010-2020:** The growth rate may have slowed due to improvements in fuel efficiency, the rise of alternative fuels, and increased public transport usage.
- **2020-2030:** Predictions often indicate a shift toward electrification, with energy consumption stabilizing or even decreasing in some scenarios due to policy changes and technological advancements.
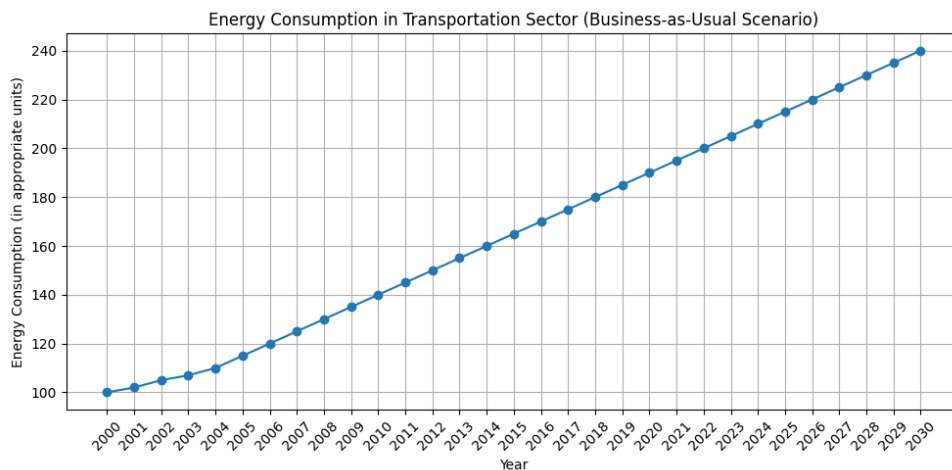
Figure 3. Energy Consumption in Transportation Sector [11].

Objectives Of Study

The main objectives of this study are
- To determine the respondents' knowledge regarding energy usage among MUST students.
- To determine the Energy consumption attitude and behavior among MUST students.
- To determine the Energy efficiency's attitude and Behavior among MUST students.

Data collection

Collecting the targeted data for this study is conducted at MUST University, this study data is collected from the main compass of the university. The data collection was conducted in September 2017, which takes around two weeks to collect the data. The research instrument (i.e., questionnaire) was distributed, and simple random sampling techniques were used. Collecting the students' feedback on the questionnaire has been done at the same time of distributing the questionnaire, the acquired result has been tabulated in Table 2.

Table 2: Collected data for the students' feedback [11].

Student	Actual Energy Savings (%)	Motivation	Awareness of Energy Efficiency
1	20	3	4
2	35	4	5
3	15	2	3
4	40	5	4
5	10	2	2
6	45	5	5
7	5	1	1
8	25	3	3
9	30	4	4
10	10	1	2

Analysis Of Data and Results

For the purpose of analyzing the primary data, SPSS software version 22 will be used to conduct the required tests. The descriptive data is used to determine the level of each variable in terms of mean and standard deviation. The frequency analysis is used for part B, C, and D, which clarifies the total answers for each point on the adopted scale. Several previous studies have adopted the descriptive and frequency analysis for determining the respondents' attitude and behavior toward the energy consumption and efficiency as demonstrated in Figure 4.
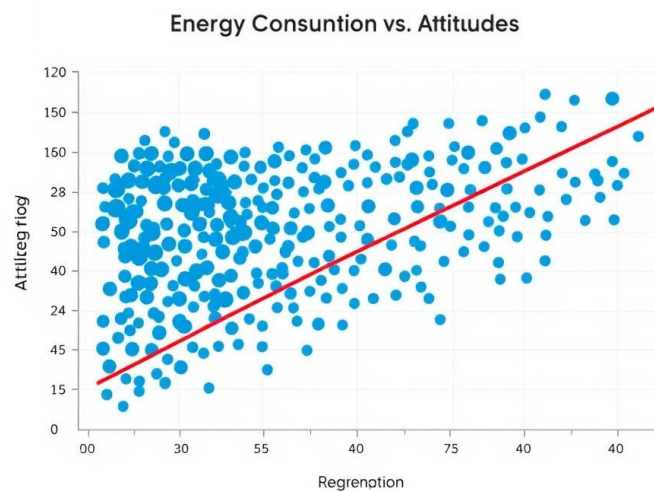
Figure 4. Comparison results between energy consumption and attitude.

Reliability test uses to measure the internal consistency of the categorical data. For the purpose of measuring the reliability test, there are four estimators of reliability test, which are Average Inter-item Correlation, Average Item-total Correlation, Split-Half Reliability, and Cronbach's Alpha. This study uses the Cronbach's Alpha estimator of reliability, which is the most frequently used for measuring the internal consistency [12]. A sample of 30 students is selected to test the reliability test for the study instrument. Table 3 showed a good level of internal consistency for the study instrument, the electricity efficiency scored 0.850 and the electricity consumption scored 0.714.

Table 3: Reliability test.

Factors	Items	Cronbach Alpha
Electricity efficiency	11	0.850
Electricity consumption	7	0.714

Table 4 shows the reliability test results for the entire study, for items construct of the electricity efficiency, the Cronbach alpha is (0.927), and the electricity consumption items is (0.759). The Cronbach alpha for both constructs has ranged between 0.7 and 1, which is considered as a good range for internal consistency.

Table 4: Reliability test.

Factors	Items	Cronbach Alpha
Electricity efficiency	11	0.927
Electricity consumption	7	0.759

This study is conducted to determine MUST students' attitude and behavior toward energy consumption and efficiency. The latest harmful effects on the environment have motivated this study to understand people's attitude and behavior outside their houses, especially in the educational institutions. There are many environmental factors to consider, which should influence the way energy use. Overall national consumption can be lowered if organizations adopt a responsible attitude towards environmental concern to encourage behavior toward energy saving. All behaviors, which humans are engage in, directly or indirectly linked to consumption [13]. A number of research studies conducted by psychologists have repeatedly shown that consumption is an integral part of people's lives and people repeatedly exposed to different aspects of consumption.

Electricity consumption in Malaysia has been rapidly increasing due to the development in the industrial, agricultural, commercial and housing sectors. Others reasons for the rise in electricity consumption include the increased population growth, the improved lifestyle and the rapid economic growth [14]. Hence, following the modern energy efficient technologies are desperately needs to implement as national energy policy. Energy policy in Malaysia, the per capita energy consumption of the majority of the population has increased considerably especially in developed countries [15].

People with more energy saving information and stronger awareness for climate change are more likely to purchase renewable energy and participates energy-saving activities [16]. Other source provides evidence that increasing energy awareness in the public domain greatly reduce energy consumption [17]. A number of factors affect energy awareness; one of these factors is the visibility of energy consumption. According to [18], people become more aware of and more involved in environmental issue, their willingness to save energy will be positively affected.

The result of this study is consent with the previous studies, which found a good attitude of people toward reducing energy consumption and improving energy efficiency. Although most of the respondents paid high attention toward the energy consumption and efficiency [19], but their attitude and behavior are more related to the environmental issues, taking into consideration that most of the university students having relative courses that related to the environment and energy issues, which affect their attitude and behavior better other people as noted from the previous studies.

Conclusion

Through the results of the analysis of geometric & traffic data we conclude that the peak hours be distributed all over the periods between the morning and afternoon and evening, and so we adopted the maximum rush hour vehicle as is shown in table 4. Also note by the results of the final analysis of traffic data of this roundabout, their max. degree of saturation 1.2 in year 2023, also that delay of this roundabout D (Sec/pcu) is the average delay per entering vehicle. Delay is estimated from the empirical relationship between delay D and degree of saturation DS, D equal 13, Queue probability Qp (%) is estimated from the empirical relationship between queue probability QP% and degree of saturation DS in this roundabout case more than (Qp 36 - 74%). The study underscores the importance of fostering a culture of energy efficiency within university settings. While students demonstrate a positive attitude towards energy conservation, their actual behaviors suggest that additional measures are necessary to bridge this gap. The influence of social norms, peer behavior, and institutional support plays a pivotal role in shaping students' energy-related practices. Some of the future recommendations may be taken in consideration as listed below:

- Awareness Campaigns: Implement targeted awareness campaigns that emphasize the importance of energy conservation and practical steps students can take to reduce consumption. Use engaging formats such as workshops, seminars, and social media to reach a broader audience.
- Incentives for Energy Efficiency: Develop incentive programs that reward students for adopting energy-efficient practices. This could include competitions, recognition programs, or discounts on utility bills based on energy-saving behaviors.

- Integration into Curriculum: Incorporate energy efficiency topics into the academic curriculum across various disciplines. This approach would not only enhance students' understanding but also encourage them to apply this knowledge in their daily lives.
- Sustainable Campus Initiatives: Strengthen campus sustainability initiatives, such as energy audits, eco-friendly infrastructure, and the promotion of renewable energy sources. Engaging students in these initiatives can foster a sense of ownership and responsibility towards energy management.
- Peer-Led Programs: Establish peer-led programs where students can share experiences and strategies for reducing energy consumption. This could enhance the social aspect of energy-saving behaviors and promote collective action.

By implementing these recommendations, MUST University can cultivate a more energy-conscious student body, ultimately contributing to broader sustainability goals and reducing the environmental footprint of the university.

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