

University Students' Stages of Engagement and Levels of Impact in Adopting Environmentally Sustainable Practices

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Abstract

Scholarly investigations into university students' engagement with environmentally sustainable practices have utilized various measures, yet there remains a significant gap in evaluating the adoption of sustainable initiatives and their associated impacts at individual, community, and societal levels. Additionally, there is a lack of understanding of student progression through the stages of change in adopting energy-efficient and sustainable behaviours. These gaps hinder the development of targeted interventions that can effectively promote consistent and impactful sustainable actions. To address these gaps, this paper presents a pilot study examining the stages of engagement and levels of impact of university students' adoption of energy efficiency and sustainability practices. Utilizing the Transtheoretical Model (TTM) (1982) and Kaufman's Five Levels of Evaluation (1994), the study explores the stages of sustainability adoption and assesses impacts at the micro (self), macro (community), and mega (societal) levels. Conducted with a sample of 79 students from Universiti Teknologi MARA (UiTM) Puncak Alam Campus, this quantitative study examined respondents' engagement and levels of impact in relation to behaviours and self-efficacy. The findings reveal that students' engagement with energy conservation and sustainability practices ranges from 'engaged but not yet consistent' to 'habitual,' indicating a mix of developing and habitual sustainable behaviours. The study also highlights a gap between awareness and action, with students demonstrating strong personal commitment to safety-related energy-efficient behaviours (micro level) but limited engagement in broader societal

initiatives (mega level). Future research should focus on expanding sample sizes, employing longitudinal designs, and testing stage-specific interventions in yielding more robust evidence. The study contributes to the academic understanding of sustainability practices and offers practical implications for fostering a culture of sustainability in higher education.

Keywords: Sustainability, SDG, Energy Efficiency, Energy Conservation, Climate Change, Stages of Change

Introduction

Sustainability and energy efficiency are critical components in the global effort to mitigate climate change and promote environmental initiatives. Sustainability refers to the practice of meeting present needs without compromising the ability of future generations to meet their own (World Commission on Environment and Development, 1987). The concept is often described through environmental, social, and economic perspectives (Alvarez-Nieto et al., 2022; Cho, 2019; Fang et al., 2022; Ulkhaq et al., 2023), which are commonly viewed as the pillars of sustainability (Ali & Khalid, 2024; Ovais, 2023). Energy efficiency, a key aspect of sustainability, involves using less energy to perform the same task or produce the same outcome, thereby reducing energy waste and emissions (Ambrose et al., 2002). These concepts are increasingly vital as societies strive to transition towards more sustainable modes of living and resource management (Atamin et al., 2023; Jehtae et al., 2021; Azhar et al., 2022).

There appears to be intense interest in the knowledge, attitudes, and behaviours regarding university students and sustainability in the current literature. Studies have shown varying levels of knowledge among students, ranging from a lack of familiarity (Chen et al., 2023; Mohamed et al., 2024; Ribeiro et al., 2021) to a well-informed understanding of sustainability concepts (Abdul-Halim et al., 2021; Al-Nuaimi & Al-Ghamdi, 2022; Azhar et al., 2022). Attitudes towards sustainability are generally positive, with many students recognizing the importance of sustainable practices and expressing favourable views (Farliana et al., 2023; Syed Azhar et al., 2022). However, the translation of these attitudes into consistent sustainable behaviours remains inconsistent, leading to a gap between knowledge, attitudes, and the actual adoption of behaviours (Alsaati et al., 2020; Jehtae et al., 2021; Zakaria et al., 2024).

The growing interest in sustainability-related knowledge, attitudes, and behaviours signifies significant research gaps. While existing studies enhance the body of knowledge on understanding patterns and trends in university students' views towards the concept and its adoption, there remains a lack of evaluation of the adoption of sustainable initiatives and their associated impact at the level of self, immediate community, or at societal and environmental levels. There is also an incomplete understanding of student progression through the stages of change in the adoption of energy efficiency and sustainable behaviours. These gaps limit the ability to develop targeted interventions that can effectively promote consistent and impactful sustainable actions.

This study aims to fill these gaps by exploring the stages of sustainability adoption among university students and assessing the impacts of their behaviours at the micro (self), macro (immediate social circle), and mega (society and environment) levels. Specifically, the study seeks to answer the following research questions:

1. What is the level of impact of university students' adoption of energy efficiency and sustainable practices?
2. What are the university students' inherent stages in the process of adopting energy efficiency and sustainable practices?
3. How confident are university students in their ability to adopt energy-efficient and sustainable practices at the individual, community, and societal levels?

Utilizing a quantitative research design, the sample consists of 78 students from a faculty at Universiti Teknologi MARA (UiTM) Puncak Alam Campus. The integration of Kaufman's Five Levels of Evaluation and the Transtheoretical Model (TTM) into the research framework enables the assessment of university students' engagement with energy efficiency and sustainability tasks by their levels of impact and the manner in which they progress through the stages of change, analysing their readiness and consistency of engagement.

The contributions of this study are multifaceted. The employment of TTM in measuring the stages of sustainability adoption provides a detailed understanding of where students stand in their journey towards consistent sustainable behaviours. Additionally, the incorporation of Kaufman's Five Levels of Evaluation offers a comprehensive evaluation of students' adoption of sustainability tasks and their associated levels of impact. These approaches help to highlight subsequent stages and areas for targeted interventions. The findings of this study enhance the scholarly understanding of sustainability practices among university students and offer practical implications for educational institutions seeking to foster a culture of sustainability.

Literature Review

Scholarly investigations into university students' engagement with sustainability practices have adopted a variety of constructs and dimensions, reflecting its multifaceted nature. Studies involving university students' adoption of sustainability initiatives most commonly explored the concept primarily as an environmental issue (Alvarez-Nieto et al., 2022; Cho et al., 2019; Fang et al., 2022). The economic construct was also examined in a number of studies (Ahamad et al (2018); Avelar & Farina (2022); Fang et al (2022), while the social construct was the least commonly explored (McCormick et al., 2015; Ulkhaq et al., 2023). Despite the varying degrees of adoption and focus, environment, society, and economy have been considered the three pillars of sustainability (Ali & Khalid, 2024; Ovais, 2023). Ovais (2023) justified the holistic and collective form these three aspects take in representing sustainability, as well as their interconnected and intricate nature.

Within these three pillars, knowledge about and the adoption of sustainability practices were the most commonly investigated dimensions. University students' knowledge and awareness of these concepts varied significantly, ranging from a complete lack of familiarity (Chen et al (2023); Mohamed et al (2024); Ribeiro et al (2021); Abedin et al (2023), to being slightly familiar (Alsaati et al (2020); Ferreira et al (2023), to having basic foundational knowledge (Radwan & Khalil (2021); Zakaria et al (2024), and some studies even reported that university students were well-versed with these concepts (Abdul-Halim et al., 2021; Al-Nuaimi & Al-Ghamdi, 2022; Azhar et al., 2022).

Despite the varying levels of knowledge, environmentally sustainable practices were held in high esteem, with university students demonstrating positive views. Studies delving into attitudes towards the concept revealed moderate to high levels of positive attitudes (Farliana et al., 2023; Azhar et al., 2022). In Atamin et al.'s (2023) study, the university students surveyed 'highly perceived' the concept, with their attitudes towards sustainability being 'highly affected'. Similarly, Cruz et al. (2018) reported that the nursing students in their study demonstrated moderate pro-environment attitudes, although their attitudes towards sustainability in health care were extremely positive.

Studies measuring students' engagement in environmentally sustainable behaviours have shown limited adoption (Alsaati et al (2020); Jehtae et al (2021) and inconsistent practice (Zakaria et al (2024), with a notable reluctance to sacrifice convenience for sustainable-efficient practices (Alsaati et al., 2020; Jehtae et al., 2021; Radwan & Khalil, 2021). Zakaria et al (2024), for example, revealed that students demonstrated minimal involvement in collective sustainability efforts, such as participating in sustainability projects, and that their engagement in energy-inefficient behaviours was deeply ingrained and widespread. Additionally, Radwan and Khalil (2021) reported positive perceptions towards sustainability-related behaviours among university students, yet these students held strong sentiments about the importance of convenience, expressing their disagreement with limiting the number of cars around campus. Jehtae et al (2021) found similar results, noting that students who advocated for energy and water conservation initiatives often placed a higher value on time-saving practices, even when these actions contradicted energy-efficient behaviours.

A notable gap between sustainable knowledge and actions has prompted the rise of studies examining university students' beliefs and attitudes towards the concept. Although students were found to be well-informed about energy conservation and sustainability initiatives (Abdul-Halim et al (2021); Al-Nuaimi & Al-Ghamdi (2022); Azhar et al (2022), the adoption of energy-efficient practices and sustainable behaviours remained limited (Alsaati et al (2020); Jehtae et al (2021) and inconsistent (Zakaria et al., 2024). Studies on beliefs and attitudes towards sustainability were motivated by the perspective that they drive practice (Cheung & To (2019); Zakaria & Ab. Wahid (2023); Zakaria et al (2016), particularly when aspects related to unsustainable behaviours were found to be deeply ingrained and habitual among respondents (Alsaati et al., 2020; Zakaria et al., 2024). For instance, Farliana et al (2023) examined university students' knowledge, attitudes, and behaviours related to sustainability across the dimensions of environment, social, and economy. They reported that students exhibited higher knowledge about sustainability compared to their attitudes and behaviours towards it. Interestingly, the findings also revealed that attitude towards sustainability was a stronger precursor for behavioural change than knowledge. These findings resonate with other studies that highlight beliefs and attitudes as significant predictors for the adoption of sustainability practices (Cheung & To, 2018; Ovais, 2023).

Sustainability among university students has also been examined in relation to its association with religious beliefs and standing (Ali & Khalid, 2024; Kondrila et al., 2024). Kondrila and his co-authors (2024) found that Sustainable Development Goals' (SDG) knowledge among pre-service religious teachers varied from inadequate to sufficient; however, they were unable to relate sustainability to religious values and lacked the motivation to integrate such values into their pedagogical practices. Kwakwa et al (2024) incorporated emotions and religion into their

research model to assess the effect of electricity conservation intentions among university students, uncovering that the effect was appliance-specific. Certain factors acted as stronger drivers for some appliances, while the intention to conserve energy for other appliances was more profoundly driven by different factors. For instance, religion was found to be an effective energy conservation inducer for laptops, refrigerators, and fans, whereas gender, energy cost, and age did not have any significant effect on energy conservation intentions.

In a number of studies, locus of control has been used as a lens to examine university students' consciousness of sustainability (Farliana et al., 2023; Ovais, 2023). Arguably, individuals with a high internal locus of control (the belief that they can initiate change) are more likely to engage in sustainable behaviours compared to those with a high external locus of control (the belief that behaviours are influenced by forces outside of their control) (Ovais, 2023). Farliana and her co-authors (2023) divided respondents in their study into two groups: internal and external locus of control. They found a greater effect on the change of desirable behaviours towards sustainability among those with an internal locus of control. Conversely, most respondents in the external locus of control group felt incapable of influencing the events around them. The authors emphasized the role of various stakeholders in instilling a sense of ownership among the youth to cultivate an internal locus of control as a precursor to the adoption of sustained sustainable behaviours.

Method

The discussion in this paper focuses on a pilot study of a research measuring the effectiveness of an intervention aimed at improving participants' knowledge, behaviours, and self-efficacy in adopting energy efficiency and sustainability initiatives. Framed by a quantitative research design, data is collected via pre- and post-surveys. For the pilot study, although participants completed both surveys, they were not exposed to the targeted intervention, as the main aim was instrument refinement. Hence, the discussion in this paper highlights the findings derived solely from the post-survey, which examines respondents' inherent placement in the adoption of energy efficiency and sustainability initiatives along the stages of change. Additionally, the findings include an examination of the level of impacts as the outcome of the respondents' engagement with the measured initiatives.

The pilot study was responded to by 79 students from one of the faculties at UiTM Puncak Alam Campus. A random sampling technique was employed for sample selection, and data was gathered through an online survey platform. The random sampling technique not only prevents bias but also encourages a more accurate representation of the parameter estimates (Noor et al., 2022; Xie, 2023). By providing an equal opportunity for everyone in the population to be selected, this technique enables the collection of all sampling units (Cresswell, 2014).

The utilization of surveys is considered appropriate as they effectively provide a consistent foundation for gathering large-scale data involving diverse groups of participants (Creswell & Creswell, 2018). Xiong (2020) posited that objectivity, generalizability, and effectiveness are the three most important attributes of surveys, ensuring consistency and uniformity in the data gathered (Creswell & Creswell, 2018).

Context

The pilot study serves as a measure for instrument refinement for a larger project targeting shifts in the adoption of energy efficiency and sustainable practices. In the larger project, 400 students from each of the five participating UiTM campuses (n=2000) attend a 4-hour interactive seminar featuring three modules on energy efficiency and sustainability practices. This seminar, part of the Green Campus Initiative by UiTM Selangor Branch (UCS) in collaboration with Tenaga Nasional Berhad (TNB), aims to fulfil the following objectives: 1) Cultivating best practices and daily routines that support the efficient and prudent use of electricity among students; 2) Raising awareness and promoting the adoption of desirable behaviours concerning energy efficiency and sustainability among students; and 3) Enhancing knowledge and skills regarding the latest technology in energy efficiency practices among students.

Theoretical Framework and Instrument Development

The pre- and post-survey instruments consist of five sections: demographic information, knowledge, behaviours, self-efficacy, and program effectiveness. However, this research paper focuses on the respondents' stages of change and their levels of impact in adopting energy efficiency and sustainable practices, as well as their self-efficacy in carrying out the measured tasks. Consequently, the knowledge construct and program effectiveness are omitted from the discussion in this paper. The data and findings presented are specific to the post-survey of the pilot study, as the participants were not exposed to the intended intervention. While the primary aim of the pilot study is for instrument improvement, it also provides insights into the respondents' energy efficiency and sustainability practices, which serve as the focus of this paper.

Content Focus

Instrument development was significantly informed by several models and initiatives. The content measured by the items is based on the Sustainable Development Goals, particularly SDG7 (Affordable and Clean Energy) and SDG13 (Climate Action). These goals are crucial components of the United Nations' 2030 Agenda for Sustainable Development, which guide global efforts towards a more sustainable future. SDG7 aims to ensure access to affordable, reliable, sustainable, and modern energy for all, emphasizing the importance of energy efficiency and renewable energy sources. SDG13 focuses on taking urgent action to combat climate change and its impacts, advocating for resilience and adaptive capacity in responding to climate-related hazards (United Nations, 2021).

Under SDG7, the focus also involves energy-efficiency-related national policies, including the National Energy Efficiency Action Plan (NEEAP) 2016-2025 (Ministry of Energy, Green Technology and Water, 2015). For example, the first two items measuring respondents' adoption of energy efficiency practices—'Leave the switches of certain electrical equipment in standby mode/on for convenience of later use' and 'Leave devices (e.g., mobile phones, laptops) charging while sleeping/for extended periods'—represent energy-wasting behaviours. These are sub-constructs measured under the NEEAP initiatives that are also aligned with SDG7 initiatives. Additionally, several items were developed with a focus on safety, emergency rescue, and assistance within the context of the use of electrical appliances, as these are key topics for intervention.

Impact Focus

In addition to items measuring specific content related to energy efficiency and sustainability practices, all items were calibrated to represent the levels of Kaufman's Five Levels of Evaluation. These levels range from input (assessing the adequacy of resources, materials, and conditions necessary for the program); process (evaluating the implementation procedures and activities); micro (measuring the immediate outcomes such as learner achievements or changes in behaviour); macro (concerned with the effects of the program on the department or organization as a whole); and mega (examining the program's impact on the external society or environment) (Kaufman & Keller, 2006). These five dimensions collectively enable comprehensive evaluation at both the organizational level and within the larger community (Kaufman & Guerra-López, 2013; Kaufman & Keller, 2006).

The mapping and development of these items enable the engagement with specific sustainable behaviours to be ascertained in relation to their impact on the self, immediate social circle, or the wider society and environment. Of the five impact levels, input and process are represented by items on knowledge and program effectiveness respectively, which are not included as part of the discussion in this paper. For example, 'Increase self-awareness/knowledge about climate change and environmental sustainability (e.g., YouTube videos, documentary series, reading)' is an item developed at the micro level (impact on self), whereas 'Consider the safety of yourself and others around you when using electrical equipment' is an item representing impact at the macro level (impact on immediate social circle). Table 1 details the impact levels and item characteristics.

Table 1

Item development and impact levels

Construct	Level of Impact	Operational Definitions	Number of items
Sustainable Actions	Micro level (self)	Adoption of energy efficiency and sustainable behaviours in daily lives with an impact only on oneself and does not directly affect others within the respondents' immediate social circle.	4
	Macro level (immediate community)	Integration and/or promotion of energy efficiency and sustainable behaviours in daily lives impacting those who are within the respondents' immediate community.	2
	Mega level (larger society and environment)	Incorporation of energy efficiency and sustainable behaviours in daily lives with the impact on society and the environment.	4
Self-efficacy	Micro level (self)	Perceived ability to engage in energy efficiency and sustainable behaviours in daily lives with an impact only on oneself.	2
	Macro level (immediate community)	Perceived ability to integrate energy efficiency and sustainable behaviours in daily lives impacting those who are within the respondents' immediate community.	3
	Mega level (larger society and environment)	Perceived ability to incorporate energy efficiency and sustainable behaviours in daily lives with the impact on society and the environment.	3

The integration of Kaufman's Five Levels of Evaluation as an integral focus allows for the examination of the extent of impact. While the micro level represents energy efficiency and

sustainable behaviours that affect only the doer, items at the macro level represent behaviours impacting the respondents' immediate social circle as well as having an impact at the micro level. Similarly, items addressing the mega level involve direct and/or indirect impacts at both the macro and micro levels.

Focus on Stages of Change

The five-point scale utilized in the instrument is aligned with the five stages of change in the Transtheoretical Model (TTM). The TTM explains and facilitates the process of change across different behaviours (Prochaska and DiClemente, 1982). The originally proposed TTM consisted of six stages of change through which individuals typically progress as they modify behaviour: precontemplation, contemplation, preparation, action, maintenance, and termination. Each stage represents a different level of readiness to change, guiding interventions tailored to the individual's current stage. In this study, and in many practical applications of the model, the focus is on the first five stages, with the 'termination' stage omitted because complete termination of temptation and sustained change without any lapses is considered rare in many behavioural change scenarios (Raihan & Cogburn, 2023).

In the original instruments (pre and post surveys), the alignment of the scale with the stages of change allows for the effectiveness of the intervention to be measured. Given the focus of this research paper on its pilot study, the discussion zooms in on ascertaining the respondents' inherent position on the stages of change at the point they responded to the post-survey.

The TTM's stages of change and the details of the 5-point scales adopted are explained in Table 2.

Table 2

TTM's stages of change and the 5-point scales of engagement

Construct	Scale	Stages of change and scale alignment		Operational Definitions
Sustainable Actions	5-point action scale	Pre-contemplation	Not a priority	Does not value the initiatives as important leading to no integration of the practice
		Contemplation	Considering	Sees the value and considering of engaging in the initiative but no actual action is taken
		Preparation	Will do it	Prepares or getting ready the aspects of one's life to integrate the initiative
		Action	Not consistent	Engages in the energy efficiency and sustainable initiative however the action is not consistent
		Maintenance	Routine	Commits in adopting the energy efficiency and sustainable initiatives as essential part of daily routine
Self-efficacy	5-point confidence scale	Pre-contemplation	Not confident	Does not perceive one's own ability in engaging in the measured task
		Contemplation	Lowly confident	Perceives with limited ability on one's own capacity in carrying out the measured task
		Preparation	Confident	Sees one's ability to commit in implementing the measured task
		Action	Highly confident	Perceives one's ability to engage in the measured task with high degree of success
		Maintenance	Will adopt as a habit	Anticipates one's ability to engage in the measured task and adopt it consistently as a routine

Validity and Reliability Measures

Several measures were undertaken to ensure the validity and reliability of the instrument. These involved an expert review process by two experts: the first, an expert in areas pertaining to sustainability and green energy, reviewed item quality in relation to the content measured and the comprehensiveness of the constructs, while the second, an expert in educational assessment, evaluated the instrument in terms of item clarity and effectiveness. Additionally, the reference to Kaufman's Five Levels of Evaluation and the Transtheoretical Model (TTM) as the research framework strengthens the instrument's quality and enables the findings to be interpreted in a rich and multifaceted manner.

Results

Instrument Reliability

A Cronbach's alpha of 0.932 was obtained for the overall scale, indicating a high level of reliability among the items.

Demographic Information of Respondents

The pilot study involved 79 university students from a faculty at UiTM Puncak Alam Campus. Among them, 61 (77%) were female, and 18 (23%) were male. The majority, 72 students (91%), were pursuing bachelor's degrees, while 7 students (9%) were enrolled in master's programs. Most participants were aged between 23 and 25 years old (n=59, 75%), followed by 16 students (20%) who were 22 years old or younger. Three students (4%) were aged between 26 and 28 years, and only one respondent (1%) was between 29 and 30 years old.

Stage of Engagement and Level of Impact of the Adoption of Energy Efficiency and Sustainability Practices

The first two research questions examined the respondents' stage of engagement in energy efficiency and sustainability initiatives and determined the levels of impact. The findings for both research questions were based on the analysis of ten items measuring energy efficiency and sustainable behaviours, as presented in Table 1. The first two items in this section represented energy-inefficient and environmentally unsustainable practices; therefore, the descriptive statistics and the scales should be interpreted in reverse.

Table 3

Descriptive statistics for the adoption of energy efficiency and sustainable practices

No	Items	impact	NP	C	WD	NC	R	mean	SD
1	Leave the switches of certain electrical equipment in standby mode/on for convenience of later use.	micro	0	1.5	12	24.5	62	4.49	.752
2	Leave devices (e.g., mobile phones, laptops) charging while sleeping/for extended periods.	micro	1.5	2.5	13	28	55	4.33	.892
3	Increase self-awareness/knowledge about climate change and environmental sustainability (e.g. YouTube videos, documentary series, reading).	micro	1.5	5.5	33	43	17	3.69	.857
4	Take precautions and follow safety guidelines when using electrical/electronic equipment.	micro	0	5	12	38	45	4.23	.852
5	Check the star rating and purchase electrical/electronic products that prioritize environmental sustainability.	mega	4	7	25	38	26	3.76	1.034

6	Consider the safety of yourself and others around you when using electrical equipment.	macro	0	4	12	40	44	4.26	.813
7	Encourage housemates, friends, and family members to adopt energy saving practice.	macro	0	6	24	41	29	3.95	.866
8	Consider the impact of using electrical/electronic equipment in daily activities on the environment.	mega	0	8	31	37	24	3.78	.907
9	Participate in energy efficiency and environmental sustainability initiatives and activities (e.g., Earth Hour, recycling projects).	mega	0	14	37	35	14	3.49	.908
10	Engage in volunteer activities with a specific focus on conservation and environmental sustainability.	mega	1.5	21	39	25.5	13	3.28	.979

*Scale (expressed in percentages): NP=not a priority; C=considering; WD=will do it; NC=not consistent, R=routine).

Stage of Engagement in Energy Efficiency and Sustainability Practices

The first research question sought to identify respondents' inherent stages of engagement in energy efficiency and sustainable practices. The placement of respondents along these stages was ascertained through the utilization of a 5-point engagement scale (not a priority, considering, will do it, not consistent, routine) that aligned with the five stages of the Transtheoretical Model (TTM): precontemplation, contemplation, preparation, action, and maintenance.

The descriptive statistics for the ten items revealed mean scores ranging from 3.28 to 4.49 and standard deviations (SD) between .752 and 1.034, suggesting varying levels of engagement and differences in consistency among respondents. The findings indicated that the university students predominantly resided in the action and maintenance stages, signifying sustainable behaviours that were not yet consistent (stage 4) and those that became habitual (stage 5).

At the Pre-Contemplation stage (Not a Priority), a small number of students (1.5%) did not view the importance of educating themselves about climate change and environmental sustainability or engaging in projects championing such advocacy. Additionally, 4% of the students did not prioritize checking star ratings or purchasing environmentally-friendly products. No response was recorded for the majority of the items in this section (6 out of 10 items), signifying a promising pattern that most respondents, to a certain degree, viewed the importance of carrying out energy-efficient and sustainable tasks.

At the Contemplation stage (Considering), items representing sustainability engagement at the societal level gathered the highest responses. A significant number of students were

considering participating in energy-efficient and environmentally sustainable practices (14%) and engaging in voluntary activities championing the cause (21%). Additionally, 6% to 8% of the students were just beginning to consider the environmental impact of their use of electrical equipment, prioritizing environmentally-friendly products when making purchases, checking star ratings before making purchases, and encouraging their family and friends to engage in sustainable practices. However, these considerations remained as intentions and were not yet followed by any actions.

At the Preparation stage (Will Do It), more than 30% to 40% of the students indicated a desire to enhance their knowledge and self-awareness about climate change and sustainability. They expressed intentions to engage in actions that advocated for the cause, such as participating in Earth Hour, recycling projects, and voluntary activities. Additionally, they were actively planning to integrate environmental considerations into their use of electrical equipment in daily activities. These intentions, although not yet followed up by actual actions, signified a high level of readiness among the respondents to embark on sustainability-related tasks and activities.

The Action stage (Not Consistent) indicates actual engagement with the tasks; however, the adoption lacked regularity. The findings revealed that many students (more than 40%) engaged in activities that enhanced their knowledge and self-awareness about climate change and sustainability, considered their safety and the safety of those around them when using electrical equipment, and encouraged family and friends to adopt energy-saving practices.

Habits centred on the safety and well-being of students and those within their immediate community characterized the Maintenance stage (Routine). This stage signifies habitual engagement in energy conservation and environmentally sustainable initiatives. Taking precautionary steps, following safety guidelines, and considering one's own safety and the safety of others when using electrical and electronic equipment were tasks embraced as daily routines, as reflected by more than 40% of the students.

The findings also revealed two deeply ingrained energy-inefficient habits that students did not see the possibility of reversing. Specifically, 62% of the students admitted to leaving electrical equipment on or in standby mode for later use, and 55% let their devices, such as mobile phones and laptops, charge while sleeping or for extended periods. These behaviours indicated that students prioritized convenience over energy conservation and sustainable practices.

Overall, the university students' engagement with energy conservation and sustainability practices ranged from 'engaged but not yet consistent' to 'habitual.' This suggested a mix of developing and habitual sustainable behaviours. The findings also revealed a small percentage of students at the pre-contemplation stage, neglecting the importance of sustainability. Nevertheless, a significant number of students were considering or preparing to adopt sustainable practices.

Impact Level of Students' Engagement in Energy Efficiency and Sustainability Practices

The second research question examined the level of impact of university students' adoption of energy efficiency and sustainability practices. It aimed to investigate the degree to which students' adoption of such initiatives was centred only on themselves (micro level), included considerations of the impact on their immediate social circle such as friends and family (macro level), or extended to encompass a broader societal or environmental impact (mega level). The findings were ascertained through descriptive statistics (means and standard deviations), emphasizing the degree to which students embraced these practices.

The findings disclosed a commendable level of commitment at the personal level; however, students' adoption of sustainability initiatives had little influence on the individuals within their immediate community and exhibited limited societal impact.

At the micro level, the focus is on individual behaviours that demonstrate personal responsibility towards energy efficiency and sustainability. The findings indicated strong engagement in energy-inefficient behaviours and unsustainable practices, demonstrating a low level of conscientiousness in their personal energy use. For instance, students were prone to leave their electrical equipment plugged in even when not in use and to leave them charging during sleep or for extended periods. Nevertheless, safety was of paramount importance, with students taking precautionary measures and following safety guidelines when using electrical equipment (mean: 4.23, SD: .852). The low SD value signifies that this practice was consistent among the students. On the other hand, efforts in self-educating about climate change and environmental sustainability recorded a moderate impact (mean: 3.69, SD: .857).

The macro level concerns the impact of student adoption of energy efficiency and sustainable behaviours on their immediate community, including housemates, friends, and family. The findings revealed that students' engagement in these initiatives had a strong impact on the individuals within their social circles. Safety is a recurring theme, with students demonstrating a high level of consideration for their own safety and the safety of others when using electrical equipment (mean: 4.26, SD: .813). Additionally, they proactively encouraged family members and friends to adopt energy-saving practices (mean: 3.95, SD: .866). These behaviours reflected a communal approach to energy use, where the well-being of others was taken into account, fostering a culture of shared responsibility and collective safety.

At the mega level, students' engagement in energy conservation and sustainable initiatives exhibited a moderate degree of impact, with mean values ranging between 3.28 and 3.78. The stronger the impact at this level, the more profound the influence it has on both the macro (immediate community) and micro (self) levels. Conversely, a moderate impact signifies a moderate effect across all measured levels. Engagement in voluntary activities that advocated for conservation and environmental sustainability, as well as projects such as Earth Hour and recycling, recorded the lowest mean values within this category. This indicated that while some students were actively engaged, a larger portion did not see the significance of such initiatives. Despite the mild effect, there was potential for improvement in activities with wider environmental impacts. For instance, considering the environmental impact of using electrical equipment in daily activities (mean: 3.78, SD: .907) and checking star ratings as well as prioritizing environmentally-friendly products when making purchases (mean: 3.76, SD:

1.034) recorded higher means. This positive awareness indicates that students were moderately aware of the broader implications of their actions, suggesting potential growth in the adoption of activities with more profound impacts.

The findings reflected strong personal engagement with energy conservation and sustainability practices, albeit with inefficiencies, and moderate influence within their immediate communities. However, their engagement in endeavours with broader societal impact remained limited.

Impact Level of Students' Perceived Engagement in Energy Efficiency and Sustainability Practices

The third research question sought to ascertain the level of impact for energy conservation and environmentally sustainable initiatives that the students perceived themselves capable of engaging in. Measuring impact level based on self-efficacy, the construct was determined through items focusing on tasks related to injury prevention and response in electrical-related accidents (corresponding directly to the seminar content), engagement in energy-efficient and sustainability-related behaviours, and the likelihood of overcoming barriers to adopting sustainability practices. The findings were derived from the descriptive analysis of eight items based on a 5-point confidence scale (not confident, quite confident, confident, highly confident, will adopt as a habit). The results are presented in Table 4.

Table 4

Descriptive statistics for level of impact of students' self-efficacy in the integration of energy efficiency and sustainable practices

No	Items	impact	NC	QC	C	HC	H	mean	SD
1	Use electrical equipment safely to avoid the risk of injury.	micro	0	5	36	27	32	3.86	.936
2	Rescue victims involved in electrical-related accidents.	macro	28	31	27	10	4	2.31	1.108
3	Provide early assistance during emergencies involving victims of electrical injuries.	macro	21	32	29	13	5	2.50	1.114
4	Influence others to adopt energy conservation and sustainable practice as part of their way of life.	macro	0	14	36	22	28	3.64	1.044
5	Make energy-efficient practices and environmental sustainability a priority in life.	mega	0	8	41	13	38	3.82	1.041
6	Engage in energy-efficient and environmentally sustainable activities even when busy.	micro	0	15.5	29	24.5	31	3.71	1.070
7	Reorganize daily routines and habits to accommodate energy efficiency and sustainable practice (e.g., recycling practices, buying local products, reducing electricity usage).	mega	0	11.5	34.5	22	32	3.74	1.037
8	Promote the importance of sustainable practices among university members, even if the initiatives are not popular.	mega	0	19	38.5	20.5	22	3.45	1.040

*Scale (expressed in percentages): NC=not confident, QC=quite confident, C=confident, HC=highly confident, H=will adopt as a habit

The findings yielded a range of mean values between 2.31 and 3.86 across eight items, indicating a broad spectrum of self-efficacy in various energy efficiency and sustainability tasks. Students felt quite confident in carrying out sustainability-related initiatives at the individual level; however, their confidence dropped significantly when faced with emergency-related tasks and those requiring more complex engagement.

Students demonstrated confidence in engaging with environmentally-sustainable activities that have an impact on themselves (micro level). A mean score of 3.86 (SD: .936) for perceived ability to use electrical equipment safely to avoid risk of injury indicated that the majority of students were confident or highly confident in performing this task. Additionally, students believed they could engage in energy-efficient and environmentally sustainable activities even when busy (mean: 3.71, SD: 1.070). This demonstrated a strong personal commitment to sustainability, reflecting their ability to prioritize these practices amidst other demands.

At the macro level, where the emphasis was on students' perceived ability to adopt sustainable behaviours with an influence on their immediate community, the responses recorded a moderate level of confidence. This was more prominent with tasks involving the provision of emergency rescue in electrical use-related accidents. For instance, students felt moderately confident in rescuing victims involved in electrical-related accidents (mean: 2.31, SD: 1.108) and in providing early assistance during emergencies involving victims of electrical injuries (mean: 2.50, SD: 1.114). The high SD also reflected consistent practice among a small number of students but a low sense of self-efficacy for the majority of other students. Conversely, advocating energy conservation and sustainable practices among peers and family members suggested a moderate to high level of confidence (mean: 3.64, SD: 1.044).

The mega level evaluates the students' perceived ability to perform sustainability tasks with influence on a broader societal and environmental scale. Here, students reflected a commitment to these values with tasks at a personal level that have an impact at macro and mega levels. The findings disclosed students' willingness to reorganize priorities to accommodate sustainability practices in their lives (mean: 3.74, SD: 1.037). Promoting sustainability practices among university members, even if the initiatives are not popular, recorded a mean score of 3.45 (SD: 1.040). This indicated students' confidence in championing the cause despite its lack of popularity.

Discussion

The pilot study analysed stages of engagement and levels of impact of university students' adoption of energy efficiency and sustainability practices. Guided by three research questions, the study sought to identify university students' stage of engagement in energy efficiency and sustainability practices; the impact levels of these engagements either on self, immediate community, or on wider society or environment; as well as the level of impact of energy efficiency and environmentally-sustainable tasks that the students perceived themselves as able to execute.

Through the adoption of a TTM-aligned five-point engagement scale, the findings for the first research question identified university students' engagement with energy efficiency and sustainability practices as primarily residing in the 'action' and 'maintenance' stages. This indicates behaviours that were either emerging but inconsistent (action) or well-established

and habitual (maintenance). The second research question focused on the levels of impact of students' sustainable practices, ascertained through the lenses of Kaufman's Five Levels of Evaluation. Impacts were categorized into micro (self), macro (immediate community), and mega (societal/environmental) levels. At the micro level, students demonstrated a strong commitment to personal energy efficiency behaviours, such as safely using electrical equipment and engaging in sustainable activities even when busy. However, there were notable energy inefficient practices that students were unwilling to give up, like leaving devices on standby or charging overnight. These findings suggested a strong inclination for behaviours that centred on personal convenience rather than engaging in tasks that prioritized sustainable deeds with wider societal and environmental impacts. Additionally, students showed strong engagement in sustainable activities influencing their immediate social circles; however, sustainable engagement with broader societal impacts was less pronounced. Activities such as participating in Earth Hour or recycling projects recorded lower mean scores, indicating that many did not perceive these initiatives as significant. The third research question evaluated the levels of impact of sustainable initiatives in relation to students' self-efficacy in executing these tasks. Students demonstrated a strong sense of confidence in carrying out sustainable behaviours with impact on self (micro level) and the wider community (mega level). However, they were only moderately confident in advocating for sustainability among peers and family (macro level).

A notable pattern across the data is the strong individual commitment to energy-efficient behaviours, particularly those related to personal safety. The high mean scores in activities such as safely using electrical equipment (mean: 3.86, SD: 0.936) indicated that students prioritized immediate, tangible actions that directly impacted their well-being. This consistent emphasis on safety and well-being highlighted an inherent understanding of the risks associated with electrical equipment and a proactive approach to mitigating these risks. The importance given to safety and security in studies measuring sustainability habits and behaviours was also supported by the findings of other studies (Cvetkovic et al., 2024; Kim et al., 2024; Tripon et al., 2023). For instance, Cvetkovic et al (2024) uncovered a positive correlation between age and the sense of safety within the context of environmental awareness. The authors conducted comparative studies involving face-to-face interviews with 400 students, 200 each from universities in Montenegro and North Macedonia, respectively. They argued that as students' age increased, they felt more threatened by the effects of resource scarcity on their safety and well-being.

Despite the high level of personal responsibility, there remained a discrepancy in energy-inefficient habits, such as leaving devices on standby or charging overnight. This finding is not surprising, as various studies have attested to the prevalence of energy-inefficient behaviours among university students, particularly where convenience overshadowed the commitment to energy conservation (Alradhi et al., 2022; Bhatia, 2022; Ferreira et al., 2011; Jehtae et al., 2021; Radwan & Khalil, 2021). Ferreira et al (2011), who examined energy consumption habits involving 4,000 smartphone users, disclosed that most charging occurred overnight, with devices being plugged in for 14 hours or more. On average, 77% of the users left their phones plugged in for 4 hours and 39 minutes after charging was completed, leading to significant energy waste. The findings of this pilot study, with high mean scores for convenient yet energy-inefficient behaviours, suggest that these habits were deeply ingrained in the respondents. Similar conclusions were drawn by Jehtae et al (2021); Radwan and Khalil

(2021), who found that university students demonstrated a strong commitment to a greener environment but often wavered under time pressure and were unwilling to sacrifice their comfort for the inconvenience of maintaining sustainable tasks and initiatives.

The persistent energy-inefficient habits despite high awareness levels suggest that future interventions should address the convenience factor, perhaps through technological solutions or behavioural nudges that make sustainable choices easier and more appealing. By making sustainable practices more accessible and integrating them seamlessly into daily routines, there is potential to enhance engagement and reduce reliance on convenience-driven, unsustainable habits.

In terms of community impact, students exhibited moderate confidence and effectiveness in influencing their immediate social circles. Encouraging friends and family to adopt energy-saving practices and considering safety in communal settings are behaviours that reflected a growing culture of shared responsibility. The findings suggested that while students were effective advocates within their close-knit communities, there was variability in their confidence levels. This variability pointed to a potential gap in advocacy skills and the need for more structured support to enhance their ability to influence others consistently.

Engagement in broader societal initiatives presents a more complex picture. Despite a commendable willingness to integrate sustainability into their daily routines and prioritize environmentally-friendly choices, students' participation in larger-scale activities such as organized sustainability events and volunteerism remained limited. The lower mean scores in these areas indicated a gap between awareness and action at the societal level. This suggests that while students understood the broader implications of sustainability, translating this understanding into active participation in societal initiatives was challenging. The findings of this study are consistent with the assertions made by Fahrianto et al (2018); Mafongso et al (2018); Perrault and Clark (2017); Ribeiro et al (2021), who observed that increased knowledge and awareness of sustainability did not necessarily result in the adoption of environmentally sustainable behaviours. Several authors have noted that sustainability knowledge alone was a weak driver for change. Cheung and To (2018); Farliana et al (2023); Ovais (2023), for example, associated the motivation to adopt sustainable behaviours with beliefs and attitudes, viewing the concept as complex and deeply intertwined with personal values. Farliana et al (2023); Ovais (2023) found that attitudes towards sustainability were a stronger driver of behavioural change compared to sustainability knowledge.

This study suggested new insights into the interplay between personal responsibility, community influence, and societal engagement. One significant finding was the interconnectedness of these levels; improvements in personal and community engagement can potentially lead to stronger societal impacts. For instance, as students became more effective advocates within their communities, their confidence and readiness to engage in broader initiatives may increase. This highlights the importance of a holistic approach that integrates efforts across all levels of impact, ensuring that individual actions are supported by community dynamics and extended to societal contributions. While students are making significant strides in adopting sustainable practices, there are also opportunities for educational institutions to play a more active role in enhancing sustainability awareness, fostering community advocacy, and encouraging broader societal engagement. By addressing

these gaps, universities can assist students to transition from individual actions to collective impact, contributing to a more sustainable future.

Limitations

The study was bounded by several limitations. First, the sample size, drawn from a single university and involving only a small number of respondents from one faculty, may limit the generalizability of the findings to broader populations or different institutional contexts. Another limitation is the relatively small number of items representing the constructs and sub-constructs measured, which might not fully capture the complexity and diversity of students' engagement with energy efficiency and sustainability practices. This limited item pool could affect the comprehensiveness and applicability of the findings. Additionally, the pilot nature of the study, which focused on post-survey responses without the effect of the intervention, may have restricted the assessment of specific educational strategies aimed at enhancing sustainability practices.

Implications, Contributions and Future Research

The findings of this study present several important implications for both the academic community and university administration aiming to cultivate energy efficiency and sustainable practices among students. First, the study highlights a critical need for developing strategies that bridge the gap between personal responsibility and broader societal engagement. Despite students' willingness to adopt sustainable practices, their participation in larger-scale societal initiatives remained limited. This suggests that universities should create more accessible and engaging opportunities for students to participate in community and societal sustainability efforts. Initiatives such as sustainability-focused service learning, community outreach programs, and partnerships with environmental organizations could provide students with practical experiences that extend their impact beyond the campus. Additionally, addressing one of the primary barriers to consistent engagement, universities should explore technological solutions and behavioural nudges to make sustainable choices more convenient and appealing.

Furthermore, targeted support and training are essential, particularly in addressing the variability in confidence levels for influencing others to adopt sustainable practices. Through partnership programs with community-based non-governmental organizations, universities should consider organizing leadership development programs focused on sustainability advocacy. These programs should aim to equip students with the skills and confidence needed to effectively promote energy conservation and sustainability practices within their communities. Such initiatives would serve as effective platforms for universities to amplify the impact of individual actions, creating a ripple effect that promotes widespread adoption of sustainable practices.

The study offers several significant contributions to the field of sustainability research, particularly within the context of higher education. Firstly, the application of the Transtheoretical Model (TTM) in measuring the stages of sustainability adoption provides a detailed understanding of where university students stand in their journey toward consistent sustainable behaviours. This framework allows for the identification of specific stages, from pre-contemplation to contemplation, preparation, action, and maintenance, enabling the development of tailored interventions that can effectively guide students from mere

awareness to habitual practice. This is a significant contribution to enhancing the body of knowledge, as current literature often lacks the capacity to provide a detailed progression of sustainable behaviours. Secondly, the integration of Kaufman's Five Levels of Evaluation (micro, macro, and mega levels) offers a comprehensive evaluation of the impact of sustainability practices at different levels. This multi-level approach provides a richer understanding of how individual behaviours influence and are influenced by community and societal dynamics. The findings reveal that although students demonstrated strong personal commitment and moderate community influence, their engagement at the societal level remains limited, emphasizing areas for targeted educational and policy interventions.

Based on the findings and insights gleaned from this pilot study, several avenues for future research are evident. There is a need to enhance the generalizability of the results through the use of larger sample sizes and more diverse participants. Future studies should involve multiple universities across different geographical areas and academic disciplines. This broader scope would provide a more comprehensive understanding of the factors influencing sustainability practices among university students, accounting for cultural, socioeconomic, and educational variations. Additionally, employing longitudinal studies would enable researchers to ascertain changes in students' attitudes, knowledge, and practices across their academic journey. This approach would help identify critical periods for intervention and assess the long-term effects of educational programs. Moreover, developing and testing targeted interventions based on the TTM is another significant area for future research. Researchers might consider designing and implementing stage-specific interventions to effectively move students from contemplation to maintenance stages, given the varying stages of engagement. Experimental or quasi-experimental designs could be utilized to evaluate the efficacy of these interventions, providing robust evidence for the most effective strategies to promote sustainable practices among university students.

Conclusion

The pilot study examined university students' adoption of energy efficiency and sustainability practices in relation to their stages of engagement and subsequent levels of impact. Framed by a quantitative design, the study involved a survey responded to by 79 students from a faculty at UiTM Puncak Alam Campus. The findings revealed a moderate influence students had on their immediate social circles and exhibited strong engagement in energy-efficient behaviours related to personal safety. However, they demonstrated inconsistent engagement in broader societal and environmental initiatives. Activities such as volunteering for environmental causes and participating in organized sustainability programs recorded lower mean scores, indicating a gap between awareness and action at the societal level. The role of convenience in shaping sustainable behaviours also emerged as a critical factor. Through targeted interventions, universities can support students in transitioning from individual actions to broader societal impacts, fostering a more comprehensive and impactful adoption of sustainable practices. Future research should aim to expand the scope, depth, and interdisciplinary nature of studies on sustainability practices among university students.

The study presented in the research paper makes significant theoretical and contextual contributions by employing the Transtheoretical Model (TTM) and Kaufman's Five Levels of Evaluation to assess the stages of engagement and levels of impact concerning university students' adoption of environmentally sustainable practices. Theoretically, it advances the

academic discourse by mapping the multifaceted stages of change that students undergo in adopting sustainable behaviors, offering a granular view of transition from awareness to habitual action. Contextually, the study addresses critical gaps in the literature by providing empirical evidence on the efficacy of targeted sustainability interventions at an individual, community, and societal level. This is pivotal for developing actionable strategies that foster a more robust culture of sustainability within higher education institutions. By integrating these models, the research not only underscores the complexity of behavior change in environmental sustainability but also enhances understanding of the mechanisms through which educational institutions can facilitate and measure such changes. The findings serve as a vital resource for educational policymakers and administrators aiming to implement and evaluate sustainability initiatives effectively. This nuanced approach significantly enriches the body of knowledge by offering both theoretical insights and practical implications that are critical for promoting sustained environmental engagement among university students.

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