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## **EXPLORING OF STUDENTS' SUSTAINABILITY AWARENESS ON ENERGY MANAGEMENT AND CLIMATE CHANGE MITIGATION IN HIGHER EDUCATION INSTITUTIONS**

**Abstract:** The increasing use of energy by humans is affecting the climate change. In light of the pressing nature of this issue, it is imperative that comprehensive and integrated efforts be undertaken with the involvement of multiple stakeholders, including higher education institutions. Universities, as institutions of higher learning, bear the responsibility of fostering greater comprehension and awareness among the younger generation regarding the management of energy and the mitigation of climate change. This study aimed to analyze student sustainability awareness to initiatives establishing a sustainable higher education environment, with a focus on energy management issues and climate change mitigation in campus. A total of 426 respondents from four universities in East Java, Indonesia, participated in this survey research. The data were collected using an online questionnaire that measured several indicators of student sustainability awareness, including environmental knowledge, pro-environmental behavior, environmental attitudes, and environmental behavior intentions. The data analysis technique employed descriptive statistics in conjunction with the statistical software package SPSS version 22 for analyzing the relationship between variables. The findings indicated that the level of student sustainability awareness at the four universities was classified as "very good," with a percentage of 55.35%. The results indicate that male students have a higher score (80.38) than female students (80.2) based on the demographic characteristics of the respondents. The findings of this research are intended to serve as a reference for higher education institutions seeking to enhance students' comprehension and engagement in energy management and climate change mitigations.

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## Introduction

The challenges of climate change and green energy use demand immediate collective action from all segments of society. The consequences of climate change and excessive energy use are already being observed globally, manifesting as extreme weather events (Gärtner & Schoen, 2021; Reser & Bradley, 2020), rising sea level (Adamo et al., 2021; Triana & Wahyudi, 2020), and reduced biodiversity (Imbert et al., 2020; McElwee, 2021). Failure to address climate change will result in further exacerbation of these consequences, which could ultimately threaten the survival of humans and the planet (Kumar et al., 2021; Malhi et al., 2020). In light of the urgency of the climate change and energy use problem, it is imperative that concerted efforts be made by a range of stakeholders, including governments, industries, mass media, and society at large (Goodman, 2022; Heshmati, 2021). Accordingly, it is imperative for the government to implement rigorous policies to curtail greenhouse gas emissions and advance the utilization of renewable energy sources. Moreover, it is imperative that society as a whole adopt more sustainable practices and develop environmentally friendly technologies (Sari & Paksi, 2023).

Environmental education for younger generations can serve as a pivotal instrument in elevating public awareness and fostering collective action (Aliman et al., 2019; Sumarmi et al., 2020). Environmental learning activities in higher education can facilitate contributions from young people through minor alterations to their lifestyle practices, such as optimizing energy efficiency, reducing plastic consumption, and selecting environmentally conscious products (Gal & Gan, 2020; Kwauk & Casey, 2021).

Universities bear a significant responsibility for equipping the younger generation with the knowledge and skills necessary to effectively address climate change. As institutions of higher learning and academic inquiry, universities are uniquely positioned to impart to their students the knowledge, abilities, and values essential for the advancement of sustainable development (Cahya et al., 2022; Giesenbauer & Müller-Christ, 2020). Universities can inculcate in their students the values of responsibility and concern for climate change and energy management. By equipping students with the requisite knowledge, skills, and values, universities can facilitate the emergence of the next generation of leaders dedicated to addressing climate change and constructing a more sustainable world. Moreover, universities can serve as models for society by implementing sustainable environmental practices on their campuses (Inayatul Karimah & Mokhtar, 2021). This can be achieved by reducing greenhouse gas emissions, conserving energy, managing and treating waste, and promoting the use of green transportation.

Students carry a pivotal role as agents of change in the implementation of energy use in climate change mitigation efforts, contributing considerably to the acceleration of the attainment of a sustainable campus environment (Aliman et al., 2019; Rachmadian et al., 2024; Sumarmi, Wahyuningtyas, et al., 2022). Environmental education serves to enhance students' awareness of the significance of energy conservation, while simultaneously promoting the implementation of environmentally friendly practices on campus (Pereira Ribeiro et al., 2021). Student participation in environmental conservation initiatives, programs, and activities can facilitate the acceleration of the sustainable environment

agenda, thereby establishing it as a pivotal factor in the creation of a greener campus environment that is responsive to climate change challenges (ARENT et al., 2020; Sumarmi et al., 2020; Sumarmi, Wahyuningtyas, et al., 2022).

The construction of university infrastructure, including new buildings, must consider its potential impact on energy consumption and carbon emissions in the surrounding area. Infrastructure that is not energy efficient has the potential to increase energy consumption and contribute to global warming (Winarto et al., 2023). Additionally, the growing activities of the academic community, including student and faculty mobility, the use of electronic devices, and an increase in waste generation, can also contribute to accelerated climate change. The mitigation of climate change by universities entails the application of sustainability principles to infrastructure development and academic community activities. This is performed to minimize negative impacts on the environment. Various innovative strategies may be employed to this end, including the use of renewable energy, energy efficiency, the reduction of greenhouse gas emissions, and sustainable waste management. These efforts are expected to facilitate the achievement of sustainable development goals and contribute to the fight against climate change.

A number of universities in Indonesia have engaged in ongoing efforts to establish environmentally friendly and sustainable campus environments through the implementation of green campus programs. The program's objective is not merely the construction of environmentally friendly infrastructure; it also strives to enhance student comprehension and engagement in the implementation of efficient energy utilization strategies that address climate change. By adopting a holistic approach and engaging all stakeholders, universities are not only implementing sustainable practices but also fostering a profound awareness and commitment among the academic community, particularly students, to preserve the sustainability of the campus environment (Alfiyyana et al., 2021). Consequently, universities in several countries have devised innovative strategies to enhance student awareness and involvement in energy management and climate change mitigation within the university context.

Similarly, a number of universities in East Java, Indonesia have proactively introduced energy-saving and climate change mitigation initiatives for facilitating environmental conservation. Among the institutions participating in this initiative are State University of Malang, Brawijaya University, Airlangga University, and Sepuluh Nopember Institute of Technology. By implementing a range of initiatives and pioneering programs, these universities are dedicated to reducing their carbon footprint by promoting sustainable practices among students. The actions undertaken by these universities demonstrate a profound concern for climate change and serve as a model for other higher education institutions in their pursuit of a more environmentally conscious campus.

This research not only determines the level of students' awareness of energy desires, but also reveals what actions students and universities have taken to control energy consumption. Students' integrated actions aim to achieve effective and efficient energy utilization. Apart from that, to produce maximum output through structured and economical technical actions. Therefore, this research focuses on actions that provide opportunities for energy management. This research compares four universities in East Java so that from these results steps and strategies can be developed so that energy management and climate change mitigation can be achieved well. In light of these considerations, this study has two central objectives. Firstly, it aims to examine student awareness of sustainability in relation

to initiatives aimed at fostering a sustainable higher education environment; and secondly, to investigate student awareness of sustainability, with a particular focus on energy management and climate change mitigation in higher education, in accordance with student demographic backgrounds.

## **Literature Review**

### ***Environmental knowledge, attitudes, and pro-environmental behavior as elements of students' sustainability awareness***

Sustainability awareness among students is increasingly recognized as a vital component of higher education. Universities play a crucial role in fostering sustainability by educating students about environmental issues, promoting eco-friendly behaviors, and encouraging a sustainable lifestyle (Berchin et al., 2021; Fissi et al., 2021). Understanding how environmental knowledge, attitudes, and behaviors interconnect provides insight into the development of effective sustainability education programs. Environmental knowledge refers to the understanding and awareness of ecological concepts, environmental problems, and the consequences of human actions on the environment (Menon & Suresh, 2020). Knowledge is a critical precursor to forming environmentally friendly attitudes and behaviors (Acosta Castellanos & Queiruga-Dios, 2022; Braßler & Sprenger, 2021). Higher levels of environmental knowledge are often linked to a greater likelihood of engaging in pro-environmental behavior, although knowledge alone does not always guarantee action.

Environmental knowledge serves as a foundation for shaping students' attitudes towards sustainability. Research indicates that students who are more informed about environmental issues tend to hold stronger pro-environmental attitudes, reflecting a concern for ecological well-being (Hossain et al., 2022; Jenna et al., 2022). Therefore, attitudes are often influenced by educational experiences, including coursework, extracurricular activities, and exposure to sustainability initiatives on campus (Al-Nuaimi & Al-Ghamdi, 2022; Elegbede et al., 2023). Attitudes towards the environment are a critical determinant of behavior. A positive environmental attitude suggests that an individual values ecological integrity and supports conservation practices (Farrukh et al., 2022). However, while attitudes are important, they do not always translate directly into pro-environmental behavior. The attitude-behavior gap has been widely discussed, with factors like social norms, habits, and perceived barriers influencing the translation of attitudes into concrete actions. Pro-environmental behavior refers to actions that contribute to environmental sustainability, such as reducing waste, conserving energy, and using eco-friendly transportation. Pro-environmental behavior can be classified into various types, including activism, non-activist behaviors in the public sphere, private-sphere behaviors, and behaviors in organizations (Farrukh et al., 2022; Hansmann et al., 2020). These actions are influenced by a combination of environmental knowledge, attitudes, social context, and personal values.

Assessing the effectiveness of sustainability education requires reliable tools to measure environmental knowledge, attitudes, and behaviors. Surveys, interviews, and observational studies are commonly used to evaluate changes in student awareness and behavior over time. Longitudinal studies provide valuable insights into the persistence of pro-environmental behavior and the long-term impact of environmental education. Future research should explore innovative methods to integrate sustainability education across disciplines, making it a fundamental component of all academic programs. Additionally, understanding the emotional and psychological drivers of pro-environmental behavior, such as empathy and connection to

nature, may enhance the effectiveness of sustainability initiatives. Universities should also continue to experiment with campus-based interventions, using behavioral science to design more effective strategies for fostering a culture of sustainability (Amaral et al., 2020).

### ***Implementation of energy management and climate change in higher education***

Universities and colleges are increasingly recognized as key actors in mitigating climate change due to their role in education, research, and the management of significant physical infrastructure. The implementation of energy management and climate strategies in higher education aims to reduce carbon footprints, enhance energy efficiency, and promote sustainable development. Institutions of higher learning are adopting holistic approaches to integrate sustainability into campus operations while engaging students and staff in climate action (Rivera & Savage, 2020). Effective energy management is foundational to reducing greenhouse gas (GHG) emissions in higher education. It involves monitoring energy consumption, identifying inefficiencies, and adopting renewable energy sources. As institutions increasingly aim for carbon neutrality, energy management has become central to campus sustainability programs (Leal Filho et al., 2021; Sotnyk et al., 2020). Strategies such as implementing energy-saving technologies, upgrading building insulation, and utilizing smart meters help universities minimize energy use and costs.

Higher education institutions are not only adopting sustainability practices on campus but also engaging in climate research and education. Universities play a leading role in studying climate science, energy systems, and sustainable solutions (Almasri et al., 2023; Leal Filho et al., 2021). This research is often integrated into the curriculum, fostering a generation of students who are knowledgeable about climate change and equipped to address its challenges. Furthermore, interdisciplinary climate courses encourage students to explore the social, economic, and technical aspects of energy management. Promoting energy conservation and climate-friendly behavior among students and staff is vital for successful energy management (Olabi & Abdelkareem, 2022). Educational campaigns, competitions, and incentives are used to encourage energy-saving practices, such as turning off lights, reducing heating and cooling, and minimizing waste. Engaging the campus community in sustainability initiatives creates a culture of environmental responsibility and amplifies the impact of institutional energy management policies.

### ***Green campus program as a policy to realize a sustainable campus environment***

Green Campus (GC) is a concept where environmental awareness and sustainability practices are integrated into the culture of a university. GC can also be defined as a practice that encourages and implements sustainability practices in all processes and activities, such as teaching, research, community service, energy and waste management, and land use through continuous monitoring and maintenance (Anthony Jnr, 2021; Pereira Ribeiro et al., 2021). Such initiatives can enhance individual values and ensure the development of sustainability practices in society. GC initiatives increase sustainability awareness in universities in implementing sustainability practices, for example through environmentally friendly technologies and energy efficiency management, which direct their behavior towards sustainability (Husic, 2024; Mulà et al., 2017).

The implementation of sustainability strategies in universities helps students gain more knowledge and realize the importance of sustainable development (Frizon et al., 2024). Students' knowledge and awareness of sustainable development do not necessarily

correlate with GC initiatives. Therefore, universities must include the concept of sustainable development in the curriculum and establish sustainability initiatives in various student activities and routines.

Universities as agents of change in educational institutions that can modify various practical efforts in accelerating green campus programs. Universities can also manage energy use in order to mitigate climate change which is inseparable from the goals of environmental education. Green campus programs can also encourage the transition to the use of new renewable energy, the implementation of energy-friendly buildings, and increasing awareness of academics in the use of environmentally friendly energy (Fahmy et al., 2023; Nugrahaningsih et al., 2023). On the other hand, reducing energy consumption and mitigating climate change can be done through learning activities, research, and community service related to the use of environmentally friendly technology.

Education is a fundamental component of any green campus initiative. Effective green campus policies integrate sustainability into the curriculum, encouraging students to engage in sustainability-focused courses, projects, and research (Amin et al., 2020; Sumarmi, Wahyuningtyas, et al., 2022; Sumarmi et al., 2021; Sumarmi, Masruroh, et al., 2022). Universities are increasingly recognizing the importance of experiential learning, where students participate in sustainability practices through campus projects, internships, and volunteer opportunities. Implementing a green campus program provides significant environmental and social benefits. On the environmental side, studies have shown that green campus initiatives reduce carbon footprints, lower energy consumption, and improve waste management. Socially, these initiatives foster a culture of sustainability, increase awareness about environmental issues, and prepare students for careers in sustainable industries.

Based on previous research, Universitat Politècnica de Catalunya (UPC), Spain, has a real-time energy consumption measurement system that functions to identify energy usage in each building and is connected to the system to produce energy monitoring indicators (Frاندoloso et al., 2018; Leite Frاندoloso et al., 2021). The University of Cambridge, England also has a plan to achieve zero emissions by integrating several studies, responsible energy use programs, reducing the use of private vehicles, and finding alternatives to reduce gas. Therefore, promoting adaptation and sustainable practices in energy efficiency and climate change mitigation on campus is key to addressing challenges and encouraging students' environmental awareness.

Evaluating the impact of green campus policies is crucial for continuous improvement and accountability. Metrics such as energy use, waste reduction, and carbon emissions are commonly used to assess the success of sustainability initiatives. Institutions are also exploring qualitative measures, such as student and faculty engagement, to gauge the effectiveness of educational and behavioral initiatives (Caeiro et al., 2020). Tools like sustainability assessment frameworks and certifications help universities track their progress and benchmark against peers (Mapar et al., 2022). As the urgency to address global environmental challenges intensifies, the role of universities in leading sustainability efforts becomes more critical. Future research could explore the role of technology in advancing green campus initiatives, such as smart buildings, renewable energy integration, and data-driven sustainability management. Moreover, there is a need to investigate the long-term social impact of green education on students' attitudes and behaviors post-graduation.

## Material and Methods

### *Survey method and scope*

This research adopted a cross-sectional survey as it aimed to collect student responses through the administration of questionnaires. The survey questionnaire was comprised of four principal sections, including demographic data, environmental knowledge, environmental behavior intentions, environmental attitudes, and pro-environmental behavior with respect to energy use and climate change mitigation. The study involved 395 respondents from four universities in East Java, Indonesia, selected based on the Quacquarelli Symonds World University Ranking (QS WUR) 2025. Some of these universities offer a variety of multidisciplinary study programs, fostering diverse scientific development and graduate schools. These universities included the State University of Malang (UM), Brawijaya University (UB), Airlangga University (UNAIR), and Sepuluh Nopember Institute of Technology (ITS). The research was conducted in June and July of 2024. The population of this study was all undergraduate students at these universities who received direct learning, research, and mentoring, as summarized in Table 1.

*Table 1. The top 4 universities of East Java, Indonesia ranked and the minimum number of respondents as indicated by the Cochran formula*

Name	Rank (QS WUR) 2025	Number of faculty members	Minimum number of respondents	Number of actual respondents	Percentage of all respondents
Airlangga University	308	27342	72	79	19
Sepuluh Nopember Institute of Technology	585	19395	51	65	15
Brawijaya University	801-850	64761	171	180	42
Malang State University	1401+	34033	90	102	24
Total		145531	384	426	100

### *Sampling*

A total of 395 questionnaire responses were collected from a sample of 145,531 students through the use of random cluster sampling, in accordance with the Cochran formula. The questionnaire was validated through consultation with experts, who reviewed the questionnaire for content validation and pilot testing. The pilot test of the questionnaire pertained to its capacity to accurately gauge the intended variables. In the pilot test of the questionnaire, experts were requested to review the questionnaire and provide feedback on pertinent and suitable questions for measuring the items in accordance with the research objectives. Content validation concerns the extent to which the questionnaire encompasses all aspects intended to be measured. In the process of content validation, experts were tasked with reviewing the questionnaire and providing feedback on whether it encompassed all pertinent aspects and whether any irrelevant questions had been included. Consequently, the questionnaire validation by experts guaranteed its validity. This process entailed a review of the questions and feedback on their relevance and appropriateness for all aspects of the research objectives. Additionally, the questionnaire's suitability was evaluated using Cronbach Alpha. Data collection involved an online survey disseminated via social media. This approach was deemed suitable for data collection in educational

research, as it offers the benefits of anonymity, efficiency, and cost-effectiveness (Kolahi & Azimiseginsara, 2023).

### ***Survey measurement***

The data collection technique employed the use of an online form, which was distributed to students through the medium of social media. The instrument utilized in this study was adapted from the UI GreenMetric (UIGM) ranking indicators, which pertain to students' understanding, behavior, habits, and commitment to energy use and climate change management. The instrument consisted of 40 closed-ended questions, which employed a Likert scale of 1 (representing strongly disagree) to 4 (representing strongly agree). These questions were related to four indicators, as described in the following:

- Environmental knowledge (10 question items): this indicator assesses students' level of understanding of energy use and climate change mitigation in higher education. The presented questions cover several topics, including the understanding of sustainable environments, green campuses, college initiatives related to energy use and climate change, as well as the use of environmentally friendly technology.
- Environmental behavior intentions (10 question items): This indicator assesses the level of concern among students regarding their commitment to taking care of the environment. The question items for this indicator include students' attitudes toward allocating income for climate change mitigation, their willingness to pay a premium for environmentally friendly products, and their inclination to engage the community in energy conservation and climate change mitigation efforts.
- Environmental attitudes (10 question items): this indicator assesses students' attitudes pertaining to energy management and climate change mitigation. The questions presented encompass student actions in energy management, attitudes towards climate change, and environmentally friendly attitudes.
- Pro-environmental behavior (10 question items): This indicator is designed to assess the extent to which students engage in pro-environmental behavior. The questions presented inquire about students' habits regarding energy utilization, environmentally friendly activities, energy-saving efforts, and the utilization of facilities to support climate change mitigation.

Furthermore, the characteristics of the respondents were documented, including gender, age, faculty and university affiliation, academic year, residence, distance from residence to universities, and technology capabilities. Furthermore, the respondents' perspectives were evaluated, particularly their level of involvement in learning and research activities pertaining to environmental issues, their level of knowledge for environmental issues, the extent to which students engage with environmental issues, and their willingness to collaborate on a voluntary basis in addressing environmental problems.

### ***Data analysis***

In the data analysis stage, the questionnaire was subjected to a process of data cleaning to ensure that it had been answered in a proper and correct manner. The scores assigned to the questions pertaining to the variables were aggregated and employed for the purpose of analysis. The data analysis was conducted using both descriptive and inferential statistics in the SPSS Version 22 software. Descriptive analysis entailed the calculation of mean, standard deviation, frequency tables, and graphs. Furthermore, this study delved more pro-

foundly into the respondents' appraisals. The written responses to the open-ended qualitative questions were employed to investigate the motivations, expectations, and challenges associated with the implementation of environmental education in higher education. The objective of this analysis was to gain insight into the perspectives of participants on energy management and climate change issues in higher education.

## Results and Discussion

### *Students Sustainability Awareness on Energy Management and Climate Change Mitigation*

The results of the data collection on the assessment of students' sustainability awareness regarding energy management and climate change mitigation, conducted on 426 respondents across three universities in East Java, yielded a very good score. The student sustainability awareness assessment questionnaire was designed to ascertain the level of understanding, awareness, attitudes, and intentions to maintain environmental sustainability, particularly in the areas of energy management and climate change mitigation. Table 2 presents the number of respondents' answers on each indicator.

*Table 2. Number of respondents indicating the response level of the forth university students sustainability awareness variables*

Variable	1 (Strongly Disagree)	2 (Disagree)	3 (Agree)	4 (Strongly Agree)
Environmental Knowledge	80	516	1568	2086
Pro-Environmental Behavior	150	803	1979	1328
Environmental Attitudes	189	449	1461	2161
Environmental Behavior Intention	87	663	2029	1481

The results indicated that most respondents assigned a score of 4 (strongly agree) and 3 (agree) to all indicators of student sustainability awareness. This suggests that students possess a favorable perception of energy management and climate change mitigation within the university context. The indicator pertaining to environmental attitudes received the greatest number of strongly agreed responses, namely 2161 answers. This indicates that students possess an environmentally conscious disposition, manifested in their pursuit of a sustainable university environment through energy-saving initiatives, the utilization of novel renewable energy sources, climate change mitigation strategies, and environmentally conscious daily practices. Nevertheless, the level of pro-environmental behavior exhibited by students remains relatively low. This is evidenced by the fact that as many as 803 respondents indicated disagreement with the presented statements. The pro-environmental behavior indicator pertains to the daily habits or activities of students that are consistent with pro-environmental action, in this case, energy management and climate change mitigation.

*Table 3. Number of respondents indicating the response level of the forth university students sustainability awareness variables*

Variable	N	Mean	Median	Mode	Std. Deviation	Min	Max
SSA	426	80,29	81,88	83,13	8,38	50	98,13

The descriptive statistical calculations presented in Table 4 indicate that the mean score for students' sustainability awareness on energy management and climate change mitigation is 80.29, with a median of 81.88, mode of 83.13, a standard deviation of 8.38, minimum score of 50, and maximum score of 98.13. Further, a more thorough examination is required, based on the categorization of the level of student sustainability awareness.

*Table 4. Result of assessment of students sustainability awareness on energy management and climate change mitigation*

Score Interval	Criteria	F	(%)
$X > 81$	Very Good	223	52,35
$65,5 < X \leq 81$	Good	189	44,37
$51,5 X \leq 65,5$	Enough	9	2,11
$X \leq 51$	Less	5	1,17
Total		426	100

The results of the assessment of students' perceptions of sustainability awareness in energy management and climate change mitigation at four universities in East Java, Indonesia, as presented in Table 5 and Figure 1, demonstrate highly positive outcomes. These findings are corroborated by the results of the student perception measurement, which indicate that 223 individuals (52.35%) fell into the "very good" category, 189 (44.37%) into the "good" category, 9 (2.11%) into the "moderate" category, and 5 (1.17%) into the "less" category. The level of student sustainability awareness in energy management and climate change mitigation at four universities in East Java is noteworthy. Accordingly, these universities are recommended to maintain and continue to involve students in energy management and climate change mitigation, as this will have implications for students' understanding and experience in protecting the surrounding environment.

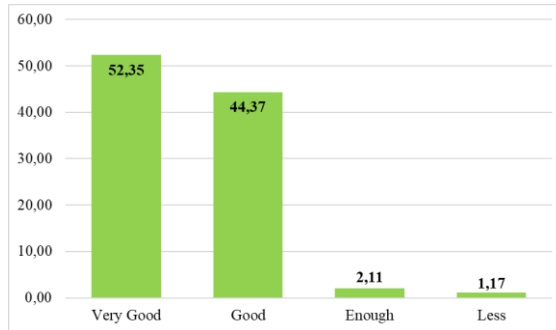


Fig. 1. Percentage of students sustainability awareness score

One of the key aspects of this study is the assessment of multiple indicators pertaining to student awareness and understanding of sustainability. As illustrated in Table 6, the highest average score is on the environmental knowledge indicator, reaching 33.29, with a median of 33, mode of 33, standard deviation of 4.44, minimum score of 16, and maximum score of 40. The environmental attitudes indicator exhibits an average score of 33.13, a median of 34, a mode of 35, a standard deviation of 4.01, a minimum value of 19, and a maximum value of 40. The environmental behavior intention indicator exhibits an average score of 31.51, with a median of 31, mode of 29, standard deviation of 3.55, minimum value of 20, and maximum value of 40. The lowest average score is observed on the pro-environmental behavior indicator, with a mean value of 30.52, a median of 31, a mode of 31, a standard deviation of 4.14, a minimum value of 19, and a maximum value of 40.

Table 5. Result of statistics analysis of students sustainability awareness responsibility values based on each indicators

Variable	N	Mean	Median	Mode	Std. Deviation	Min	Max
Environmental Knowledge	426	33,29	33	33	4,44	16	40
Pro-Environmental Behavior		30,52	31	31	4,14	19	40
Environmental Attitudes		33,13	34	35	4,01	19	40
Environmental Behavior Intention		31,51	31	29	3,55	20	40

In addition, the measurement of student sustainability awareness is also essential, with a particular focus on the influence of gender. The objective is to ascertain the extent of sustainability awareness among male and female students. The results of the measurement of student sustainability awareness based on the gender of the respondent indicate that male students have an average score that is classified as good, as compared to female students. The average value of male students is 80.38, while the average value of female

students is 80.20. These results demonstrate insignificant differences in scores for SSA based on student gender.

*Table 6. Result of statistics analysis of students sustainability awareness responsibility values by gender*

Variable	N	Mean	Median	Mode	Std. Deviation	Min	Max
Male	216	80,38	81,56	83,13	9,03	50	98,13
Female	210	80,20	81,88	84,38	7,66	50	98,13

Based on the results of the statistical tests displayed, there are differences in students' sustainability awareness at 4 universities. This calculation aims to see the level of student awareness based on university. The calculation results show that the average value of students' sustainability awareness at Airlangga University is higher with a result of 81.21 when compared to ITS which has an average value of 79.49 UB with an average value of 80.49 and UM with an average value of 79.73. Based on these results, it shows an insignificant difference in students' sustainability awareness values for the four universities.

*Table 7. Result of statistics analysis of students sustainability awareness responsibility values by gender*

Variable	N	Mean	Median	Mode	Std. Deviation	Min	Max
Airlangga University	79	81,21	82,5	83,13	6,2	69,38	98,13
Sepuluh Nopember Institute of Technology	65	79,49	79,38	76,88	9,86	50	97,5
Brawijaya University	180	80,49	82,5	84,3	8	50	98,13
State University of Malang	102	79,73	80	76,88	9,44	50	98,13

The characteristics of the respondents in this study include university of origin, year of entry, gender, age, place of residence, distance from residence to campus, and respondents' ability to use technology. The results of the demographic analysis of respondents are presented in Table 8. Based on the results of the demographic analysis of respondents, UB students filled out the most questionnaires, namely 180 people (42.3%) and ITS students filled out the least questionnaires, namely 65 people (15.3%). Students in the 2023 academic year dominated this study, namely 124 people (29.1%) and students in the 2019 academic year were slightly involved in this study, namely only 11 people (2.6%). In addition, male students were most involved in this study, namely 216 people (50.7%) and female students were 210 people (49.3%). Students aged 20-22 years were mostly involved in this study, namely 158 people (37.1%), while students aged <20 years were only 52 people (12.2%). Most of the student respondents live in boarding houses, namely 259 people (60.8%), rent houses as many as 99 people (23.2%), and live at home as many as 68 people (16%). Based on the distance of residence to campus, most of the distance of student residence to campus is 1-3 km as many as 187 people (43.9%) and only 40 people (9.4%) have a distance of residence to campus <1 km. In addition, based on technological mastery, most students have sufficient ability to master it, namely 207 people (48.6%).

*Table 8. Result of assessment of students sustainability awareness on energy management and climate change mitigation*

Indicators	Criteria	F	(%)
University	UNAIR	79	18,5
	ITS	65	15,3
	UB	180	42,3
	UM	102	23,9
Academic year	2020	94	22,1
	2021	105	24,6
	2022	92	21,6
	2023	124	29,1
	2019	11	2,6
Gender	Male	216	50,7
	Female	210	49,3
Age	<20	52	12,2
	20-22	158	37,1
	23-25	144	33,8
	>25	72	16,9
Residence	Boarding house	259	60,8
	Rent house	99	23,2
	Home	68	16,0
Distance from residence to universities	< 1 km	40	9,4
	1 - 3 km	187	43,9
	4 - 6 km	140	32,9
	> 6 km	59	13,8
Technology capabilities	Beginner	149	35,0
	Intermediate	207	48,6
	Advance	70	16,4

## **Discussion**

Higher education plays a pivotal role in fostering a sustainable environment (Lustiyati et al., 2023). Students are equipped with the necessary knowledge, behavioral intentions, attitudes, and actions to become agents of environmental sustainability. This is achieved through the integration of four pillars of sustainability, comprising of environmental knowledge, environmental behavioral intentions, environmental attitudes, and pro-environmental behavior. It is imperative that higher education institutions and students take a proactive stance in achieving the Sustainable Development Goals (SDGs) through the implementation of policies and practices that promote environmental initiatives (Zhang, 2022). The assessment of students' sustainability awareness regarding energy management and climate change mitigation yielded a mean score of 80.29. Based on this assessment, the highest indicator was identified as environmental knowledge. Environmental knowledge, in this context, refers to an individual's comprehension of environmental issues and their

subsequent actions aimed at enhancing environmental quality (Estiningtyas et al., 2022). An individual's environmental care attitude may be discerned by examining their response to environmental conditions, which may manifest as positive or negative sentiments (Dewi & Atika Angraini, 2022). This response is shaped by three fundamental elements, namely the cognitive component, which encompasses perception and knowledge of environmental issues; the affective component, which encompasses feelings or emotions toward the environment; and the conative component, which encompasses the tendency to act or behave towards the environment (Shoeibi, 2021).

Posits that an understanding of the environment can positively influence student attitudes (Hanafi et al., 2021). The students from the four universities demonstrated an exemplary awareness of sustainability in energy management and climate change mitigation. Therefore, universities should facilitate student involvement in environmental protection practices. The level of student involvement is positively correlated with environmental awareness and concern. Conversely, a lack of student engagement is associated with reduced environmental concern (Mulianti et al., 2022). Currently, numerous campus programs are in place to promote environmental stewardship, with the objective of fostering knowledge, values, attitudes, behaviors, insights, and concern for the environment. Students who possess ecological knowledge are better positioned to contribute to environmental protection activities, given their behavioral commitment to protect the environment (Fubani et al., 2024).

A total of 52.35% of students surveyed indicated that they perceive awareness and environmentally friendly practices on campus to be in the very good category. This indicates that students adhere to sustainable practices within the campus environment. Students who are environmentally conscious will endeavor to mitigate the impact of their actions and cultivate a long-term perspective. This, in turn, gives rise to sustainable behavior (Al-Shatnawi et al., 2020). It is imperative that the role of students as agents of change be optimized in order to facilitate the involvement of action aimed at addressing climate change. Students represent an influential generation with the potential to drive change in sustainable lifestyles and environmental stewardship. The promotion of sustainable lifestyles is contingent upon the development of critical thinking and mastery of science and technology. However, students require support and assistance to fully actualize their capacity for pro-environmental behavior (Yuli Remondo et al., 2022). The results of measuring student perceptions of student sustainability awareness in energy management and climate change mitigation indicate that the pro-environmental behavior indicator attains the lowest average value of 30.52.

The dearth of pro-environmental conduct can be attributed to a paucity of interest and concern for the natural environment (Effendi, 2023). The level of knowledge and awareness of environmental ethics, individual motivation, and the barriers that students may face can affect low pro-environmental behavior (Sugiarto & Gabriella, 2020). Students who lack a comprehensive understanding or awareness of environmental issues tend to exhibit a diminished level of pro-environmental behavior. Furthermore, the constraint of limited resources, whether temporal, financial, or pertaining to access to pro-environmental facilities, impedes students' capacity to embrace more sustainable behaviors (Baga et al., 2022). Personal priorities, needs, and desires also exert influence on pro-environmental behavior in certain circumstances. Educational institutions, particularly universities, play a pivotal role in disseminating environmental knowledge to students. This is achieved through the fostering

of pro-environmental behavior through relevant activities or organizations that can yield benefits for society and the environment on a broader scale.

The mean values for ethical behavior and environmental behavioral intentions are 33,13 and 31,51, respectively. Environmental ethics serves as a benchmark for gauging responsibility and respect for the environment (Begum et al., 2022). Environmental ethics among college students is concerned with the awareness of the ethical implications of their actions about the environment. Furthermore, environmental behavioral intention can be defined as the behavior and mindset of students who demonstrate concern for the environment. Environmental behavioral intentions must also be aligned with moral sensitivity (ethics) in order to ensure the continued improvement of consistency in environmental actions within the campus area (Herman et al., 2023). The findings of this study indicate that men exhibit a higher level of sustainability awareness than women. The results also suggest that male students present a higher level of sustainability awareness than female students. The average score for male students was 80,38, while the average score for female students was 80,20. Nevertheless, this discrepancy is not particularly pronounced. The underlying causes of these differences can be attributed to varying levels of concern for the surrounding environment, engagement in environmentally conscious behaviors, and moral accountability for environmental stewardship (Rabbianty et al., 2022).

The results of the calculation demonstrate that the average level of sustainability awareness among students at Airlangga University is higher than that observed among students at Sepuluh Nopember Institute of Technology, with an average value of 79.49, Brawijaya University with an average value of 80.49, and State University of Malang with an average value of 79.73. Airlangga University is actively engaged in environmentally friendly and sustainable practices for universities. One of the pertinent activities in the domain of environmentally friendly practices is the optimization of efforts to reduce carbon emissions and conserve resources on campus. Students are directly involved in the resolution of environmental issues within the boundaries of Airlangga University. This is in accordance with research findings from (Kristanto et al., 2021) indicating that at least 39 activities related to environmentally friendly practices have been conducted by students at Airlangga University. Students engage in these activities through both academic and non-academic avenues, with one such avenue being the implementation of environmental programs (- & Cahyani, 2020).

Similarly, the Sepuluh Nopember Institute of Technology fosters collaboration among all stakeholders to promote environmental stewardship collectively, through environmental movements that address environmental issues and global warming. One environmental program that has recently been implemented at the university is the Eco-Campus (Green Campus) Program. Consequently, the Sepuluh Nopember Institute of Technology eco-campus program is not a faculty-specific initiative; rather, it is a university-wide endeavor. From the outset, the design of the building incorporated the concept of a green building, namely the elimination of air conditioning in lecture rooms. The building area is rather landscaped with green space, with the survival of plants being the responsibility of students who utilize the area.

Sustainability awareness in energy management and climate change mitigation is also pursued by students at Brawijaya University (UB). A study conducted by one student of Brawijaya University, (Dewa et al., 2016) report that efforts are being made to minimize energy use, such as utilizing natural light in each lecture hall. As much as 30% of the floor

area used for lectures is illuminated by natural light. This practice of sustainability awareness is an effective means of addressing climate change on campus. Higher education efforts in sustainable development will be successful if supported by the attitude or behavior of students who are aware of the importance of energy management and climate change mitigation (Dewa et al., 2016).

In addition, the State University of Malang (UM) has demonstrated a dedication to sustainable development, as evidenced by the institution's green campus policy (Erina & Pujiningsih, 2022). In 2019, the State University of Malang established a Green Campus Task Force, comprising not only faculty members but also students. Students play an active role in supporting climate change mitigation in the campus area. For example, they participate in maintaining green open spaces and adhere to the policy of limiting the number of motorized vehicles for new students. Some of these activities are carried out with the objective of reducing the carbon footprint and the presence of pollutants in the campus environment. The sensitivity of the student body in this case aims to facilitate a change in attitudes, mindsets, concepts, and thoughts about the concept of an eco-campus, which is very useful in the future. The practice of eco-friendly habits will contribute to the formation of new habits among the students.

## **Conclusion**

The analysis results on students' sustainability awareness of energy management and climate change indicate that the level of SSA of students at four universities in East Java, Indonesia is in the very good category. The environmental knowledge indicator exhibited the highest mean score, at 33.92, in comparison to other indicators, including environmental attitudes (33.13), environmental behavior intention (31.51), and pro-environmental behavior (30.52). This is corroborated by the numerous initiatives undertaken by universities to accelerate sustainable energy management and climate change mitigation within their campuses. Recommendations for universities are based on respondents' suggestions to accelerate environmental programs, engage multiple stakeholders, and prioritize green practices within the university environment. Implementing these changes can facilitate the integration of environmental issues within universities and encourage positive environmental impacts on universities in East Java. Prioritizing environmental responsibility can contribute to sustainable development and inspire positive change in society.

In light of this study's findings, several recommendations are put forth for maintaining the level of SSA in higher education in East Java. The recommendations include the establishment of programs focused on environmental sustainability at various academic levels and the integration of environmental education into interdisciplinary studies. This can be extended to support environmental sustainability and initiatives that promote "green universities," active involvement of various stakeholders in the decision-making process, creation of green spaces on campus, nature-related student organizations, and promotion of ecotourism. Furthermore, it is recommended that comprehensive environmental guidelines be developed to optimize the use of new renewable energy and to mitigate climate change. Through the implementation of energy management and climate change mitigation, the college can effectively contribute to the incorporation of environmental issues on campus and improve environmental sustainability more broadly in East Java. This recommendation underscores the importance of enhancing SSA in East Java's universities, enabling students to fulfill an important role as a key social institution and positively influence the surrounding community.

Students who have good awareness will encourage better environmental sustainability. Energy management does not only focus on financial benefits, but also environmental and social benefits. Profits are obtained because energy management encourages us to maximize the energy we have, so that it does not have an impact on energy waste that damages the environment. Implementing energy management can reduce energy consumption and CO<sub>2</sub> discharge. Apart from that, energy efficiency is related to actions to minimize energy consumption in various higher education activities in East Java.

Data availability statement: The data that support the findings of this study are available from the corresponding author, RHR, upon reasonable request.

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