Journal of Artificial Intelligence and Engineering Applications

Website: https://ioinformatic.org/

June 2026. Vol. 5. No. 3; e-ISSN: 2808-4519

Analysis of Green Computing Implementation in Efforts to Improve Resource Efficiency in the Campus Environment

Alfin Budiman Sihotang*

Computer Science, Science and Technology Study Program, State Islamic University of North Sumatra, Indonesia
alfinbudiman02@gmail.com

Abstract

This study aims to analyze the level of green computing implementation in efforts to improve resource efficiency in the campus environment. The primary problem addressed is the high energy consumption in higher education environments due to the increasing use of information technology devices, necessitating efficient and sustainable energy management measures. This study employs a mixed methods approach, combining literature review with quantitative data collection through questionnaires to obtain data on user understanding and behavior regarding green computing. The results indicate that the majority of respondents demonstrate a good understanding of energy efficiency. Based on the data obtained, the authors conclude that the level of awareness and implementation of green computing among students is very good. The findings also reveal that students have a high concern for the impact of energy consumption on the environment and support energy conservation efforts. Overall, this study demonstrates that the application of green computing has great potential for development through broader research and targeted campus policies. This research is expected to serve as a foundation for developing more efficient energy policies in higher education.

Keywords: *Campus; Energy Efficiency; Gren Computing; Mixes Methods; Sustainability*

1. Introduction

In Indonesia, universities are increasingly expected not only to serve as centers of education but also to pioneer positive change regarding sustainability. One concept adopted by universities in support of sustainable development is the Green Campus concept [1]. Green Campus is an initiative aimed at creating a healthy environment that benefits the campus community [2]. Changes to existing infrastructure represent one of the greatest challenges in achieving energy efficiency. Given that many buildings in Indonesia have not yet met green building standards, efforts are needed to improve operational management and building utilities. Research indicates that buildings adhering to green construction principles can significantly reduce energy consumption [3]. Electricity is a major contributor to climate change, as thermal power plants that generate electricity also release large amounts of carbon dioxide and other harmful particles into the atmosphere, leading to global warming and climate change [4]. The use of ICT is not without side effects; among them is increased electricity consumption, which leads to rising monthly electricity bills. Inefficient energy consumption also contributes to environmental damage due to increasingly high carbon emissions released into the environment [5]. In this highly advanced era, nearly everyone requires a computer and a mobile phone. Society has become almost dependent on these two technological tools, and this dependence leads to excessive electricity use, resulting in increased carbon dioxide production that affects global temperature rise [6]. In response to this, a movement known as Green Computing has emerged, representing an environmentally friendly computing initiative aimed at minimizing or entirely eliminating the harmful effects of technology use on the environment [7].

Green Computing is a form of eco-friendly program that emphasizes the utilization and use of ICT devices and their infrastructure by reducing excessive electricity consumption and environmental waste disposal [8]. The goal of green computing is to improve computing performance while reducing energy consumption and carbon footprint [10]. The implementation of green computing in the campus environment can improve efficiency and reduce electricity consumption, as well as minimize negative environmental impacts [11]. Based on this phenomenon, it is necessary to elaborate on how to properly utilize Green Computing technology to educate individuals on applying Green Computing in daily practice. The implementation of Green Computing in an institution or company will have a positive impact: in addition to reducing CO2 emissions, it can also reduce resource costs and serve as a learning foundation for students in applying environmentally friendly technology in the workplace and daily life [15].

2. Research Methodology

The authors employ a mixed methods approach to gather information and collect data.

2.1. Mixed Methods

2.1.1 Qualitative stage

In the qualitative stage, the research was conducted by reviewing previous literature with the aim of comparing theoretical findings from various journals. The objective was to identify characteristics, similarities, and differences in concepts developed by previous researchers.

2.1.2 Quantitative stage

In the quantitative stage, the study used questionnaire instruments to strengthen the analysis with numerical data describing the level of green computing implementation and understanding in the higher education environment. This mixed approach was chosen so that the research findings not only reflect consistency across literature but also have an empirical basis from respondents' perceptions.

3. Results and Discussion

Adopting the idea of green computing on campus is a strategic step toward improving resource efficiency and supporting university sustainability goals. The number of electronics used in campus operations has increased as a result of growing information technology needs. Consequently, more cost-effective and environmentally friendly resource management has become not merely an option but a necessity.

3.1. Energy Efficiency Strategies for IT Devices and Systems

Energy efficiency strategies for IT devices and systems focus on controlling and selecting more efficient technologies. Implementing highly efficient devices, appropriate operational settings, and optimizing system support can help reduce electricity consumption without diminishing performance. Additionally, the use of advanced technology and good operational management helps create a more energy-friendly environment. These measures not only save money but also help reduce campus carbon emissions.

3.1.1 Use of energy-efficient air conditioning

One way to save electricity in classrooms, laboratories, and administrative spaces is to use energy-efficient air conditioning. The use of inverter AC or low-power AC units, along with routine maintenance such as cleaning filters and installing automatic timers, can also help optimize energy use without reducing user comfort.

3.1.2 Computer usage management

Managing computer usage is a crucial step in implementing Green Computing. This includes configuring power-saving modes such as sleep mode, hibernate mode, and other power-saving settings. Institutions can also encourage the use of Energy Star-certified computers or laptops that are more energy efficient. Furthermore, the use of LED monitors and replacement of power-hungry devices can significantly improve efficiency. Training users to turn off devices when not in use is also part of this strategy.

3.1.3 Server virtualization implementation

The application of server virtualization a technology that allows multiple systems to run on a single physical server reduces the need for extensive hardware. Virtualization reduces server space and electricity usage, improving energy efficiency and reducing overall equipment maintenance costs.

3.1.4 Utilization of renewable energy

The utilization of renewable energy, such as solar panels, can be used to meet part of the campus electricity needs. The adoption of renewable energy not only reduces dependence on conventional electricity sources but is also a strategic step in supporting environmental sustainability. Furthermore, energy storage systems such as batteries combined with solar panels can ensure a stable energy supply even during power outages.

3.1.5 Implementation of a smart energy management system

A smart energy management system (SEMS) enables real-time monitoring of electricity usage across all campus facilities. The system can provide reports on specific buildings, rooms, or devices, enabling management to make data-driven decisions. Additionally, this technology can be integrated with automation devices such as light and occupancy sensors to automatically turn devices on or off.

3.1.6 Reduction of paper use (paperless system)

Digitizing various processes, including assignment submission, digital attendance, e-learning, electronic administration, and cloud-based document storage, contributes to the implementation of a paperless system. Campuses can save money and reduce the need for printing equipment, ink, and printers by using less paper.

3.1.7 Electronic device recycling program (e-waste recycling program)

The objective of the E-Waste Recycling Program is to ensure that electronic items such as computers, printers, cables, and other devices that can no longer be used are not simply discarded as ordinary waste. These devices can be reprocessed or partially refurbished with the assistance of e-waste recycling vendors or groups, thereby reducing their environmental impact and minimizing hazardous waste.

3.2. Comparative Analysis of Previous Research

To identify common patterns and differences in green computing usage, a comparative analysis was conducted on three relevant journals. The following table presents the summary of findings.

Table 1 : Comparison of Green Computing Implementation Aspects Across Three Journals

Aspect	Summary of Findings from Journals A, B, and C
Research Focus	Journal A focuses on green computing implementation campaigns. Journal B emphasizes energy calculation. Journal C focuses on implementation and user awareness.
Research Method	Journal A uses literature study and observation methods. Journal B uses observation and energy calculation methods. Journal C employs literature review, observation, and interviews.
Research Object	Journal A: Campus community and campus ICT devices. Journal B: 17 computer labs with 457 PCs. Journal C: Administrative rooms and classrooms (12 laptops and printers).
Energy Savings	Journal A: Not yet optimal. Journal B: Very high electricity consumption (241,920 kWh/year), energy-intensive PCs. Journal C: User behavior is not energy-saving; power modes rarely used.
Energy-Efficient Devices	Journal A: Migration to new devices recommended. Journal B: Recommends use of laptops/All-in-One (30% more efficient). Journal C: Many old devices; usage not yet efficient.

3.3 Respondent Data

The following presents the respondent data from the research questionnaire distributed to respondents. The respondents in this study were students from several universities. Based on the data obtained, the total number of respondents was 78 individuals, with the majority coming from University A.

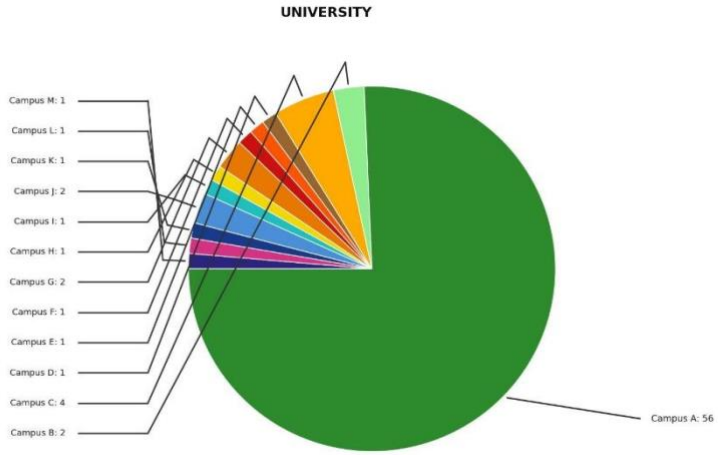

Fig. 1: Respondent data chart

3.4. Frequency of Laptop or Computer Use for Academic Activities

Based on the data obtained, students more frequently use laptops or computers for academic activities, while some students rarely or never use computers or laptops for academic purposes.

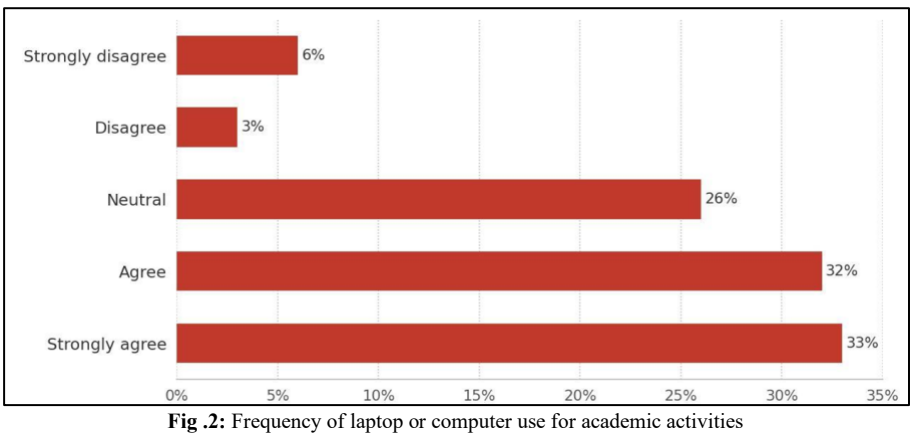

Fig .2: Frequency of laptop or computer use for academic activities

3.5 Preference for Personal Devices Compared to Campus Devices

Based on the data obtained, students more frequently use personal devices rather than campus devices, while some students prefer to use campus devices over personal ones.

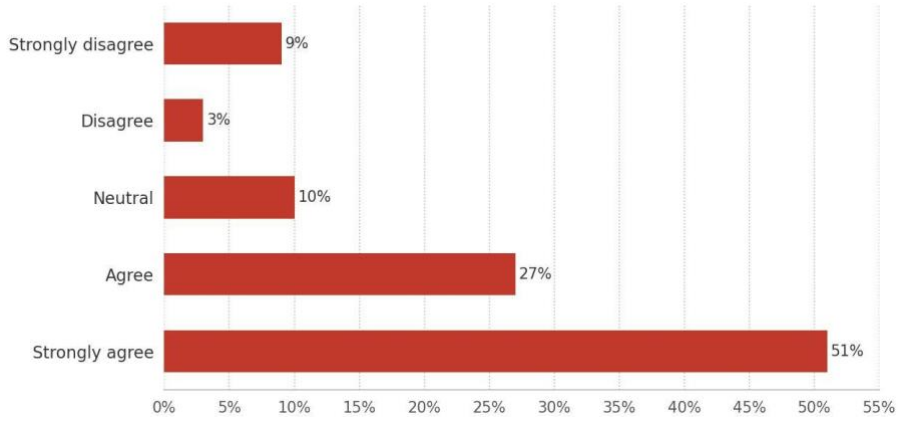

Fig. 3: Preference for personal device use compared to campus devices

3.6. Utilization of Digital Storage to Reduce Paper Use

Based on the data obtained, the majority of students use digital storage to reduce paper use, while some students still use paper for storing data.

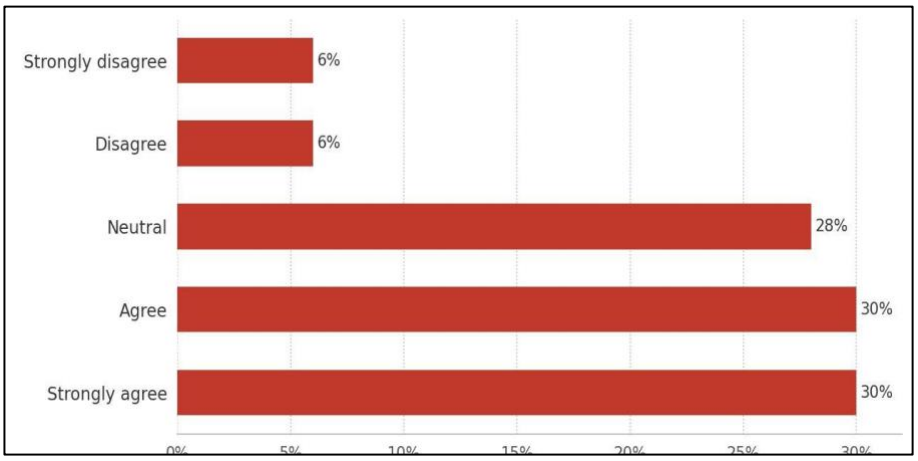

Fig. 4: Preference for digital storage utilization to reduce paper use

3.7 Level of Consistency in Turning Off Devices

Based on the data obtained, students more frequently turn off their devices after use, while some students rarely turn off their devices after use.

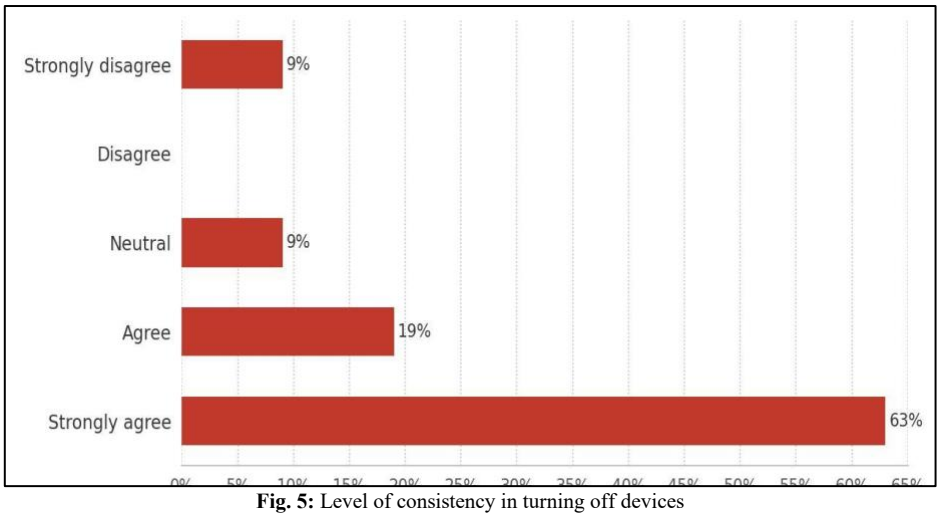

Fig. 5: Level of consistency in turning off devices

3.8 Respondents' Understanding of Device Energy Efficiency

Based on the data obtained, the majority of students understand device energy efficiency, while some students still do not understand how device energy efficiency works.

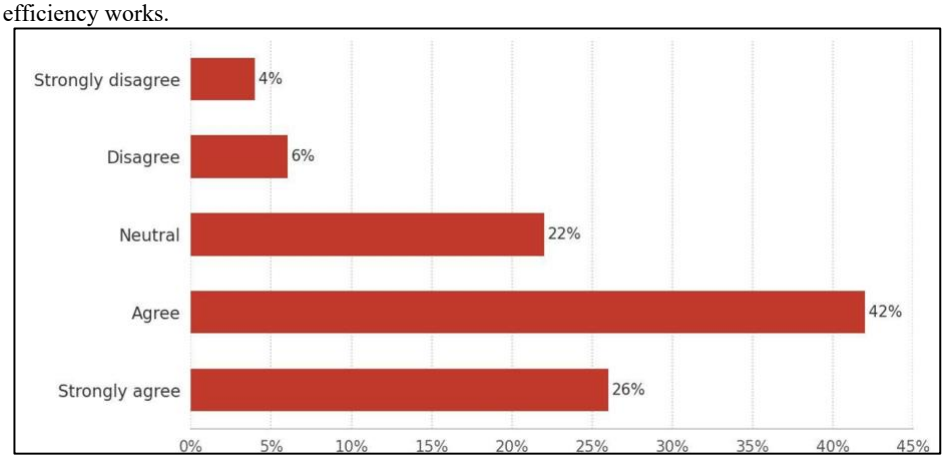

Fig. 6: Respondents' understanding of device energy efficiency

3.9 Respondents' Understanding of the Impact of Energy Waste on the Environment

Based on the data obtained, the majority of students understand the impact of energy waste on the environment, while some students do not yet understand the impact of energy waste on the environment.

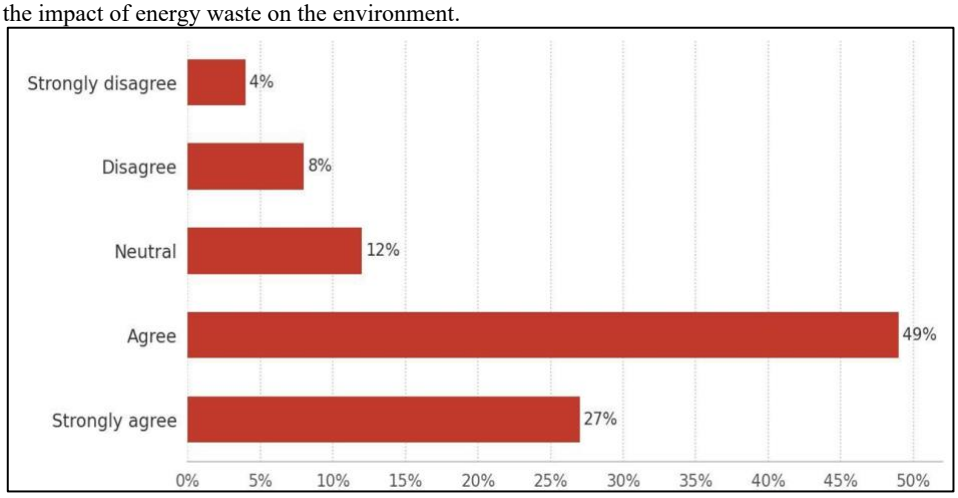

Fig. 7: Level of respondents' understanding of the impact of energy waste on the environment

3.10 Respondents' Knowledge of Energy Efficiency in Old and New Devices

Based on the data obtained, the majority of students understand that the use of older devices is more energy-intensive compared to newer devices.

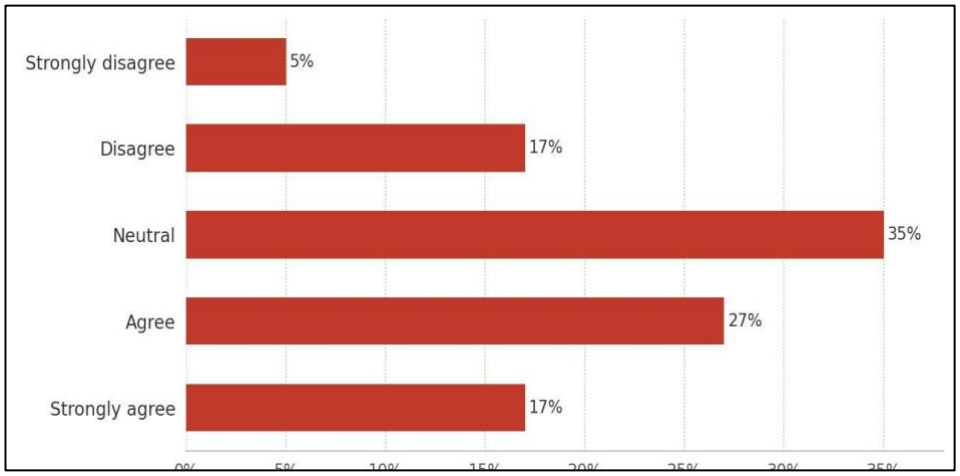

Fig. 8: Respondents' knowledge of energy efficiency in old and new devices

3.11 Respondents' Understanding of LED Lamp Energy Efficiency

Based on the data obtained, the majority of students understand that LED lamps are more energy efficient than conventional lamps.

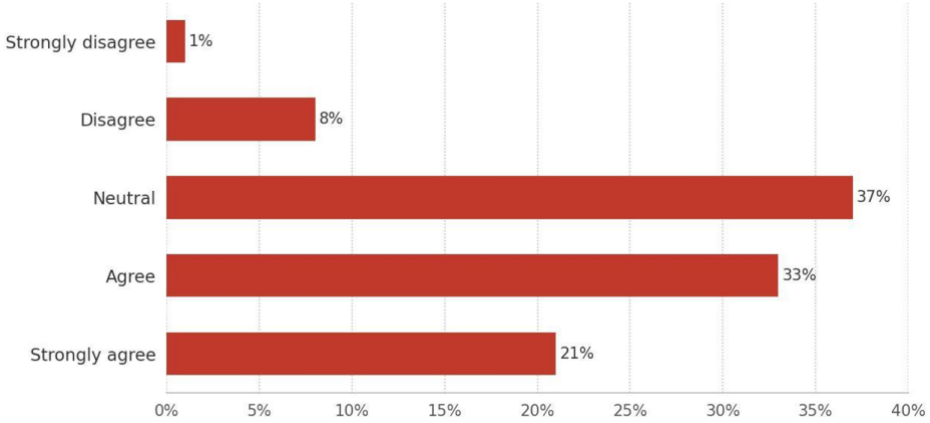

Fig. 9: Respondents' understanding of LED lamp energy efficiency

3.12 Level of Respondents' Agreement on the Implementation of Energy-Efficient Devices

Based on the data obtained, the majority of students agree that the campus should replace old devices with energy-efficient ones.

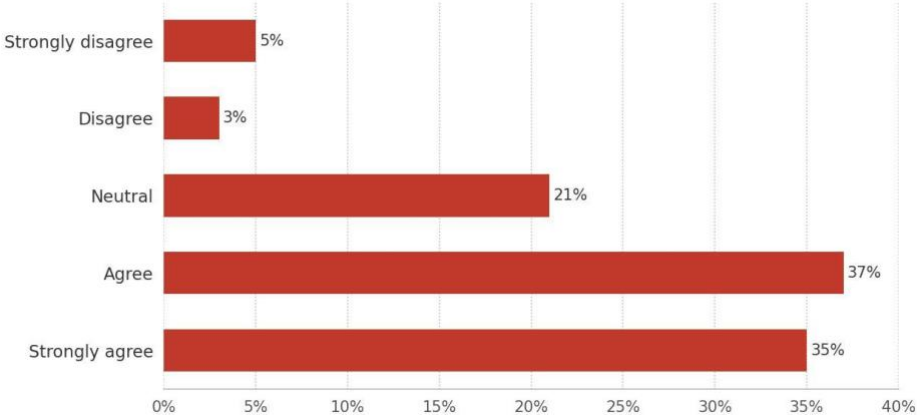

Fig. 10: Level of respondents' agreement on the implementation of energy-efficient devices

3.13 Respondents' Support for the Implementation of an Energy-Saving System on Campus

Based on the data obtained, the majority of students support campus policies in implementing an energy-saving system.

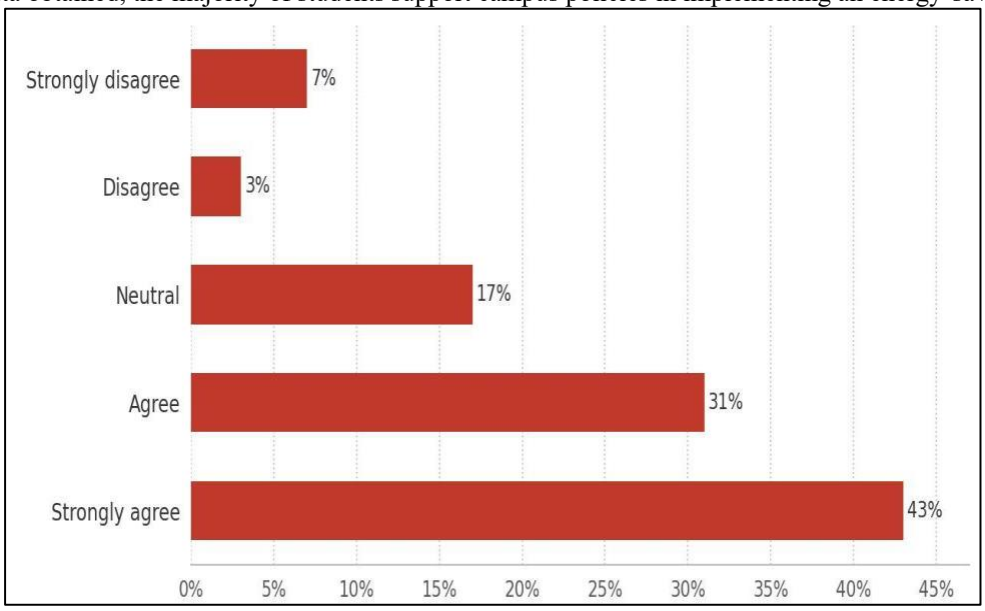

Fig. 11: Respondents' support for the implementation of an energy-saving system on campus

4. Conclusion

This study aimed to analyze the implementation of green computing in efforts to improve resource efficiency in the campus environment using a mixed methods approach, combining literature review with quantitative data from questionnaires. The analysis results indicate that the level of awareness and understanding of green computing among students falls within a good category, as evidenced by the respondent data. The strength of this study lies in its methodology, which provides a comprehensive overview from both theoretical and empirical perspectives, thereby strengthening research accuracy. However, this study still has limitations in terms of the number of respondents, as it was conducted at only a few campuses, meaning the results cannot yet be applied on a broader scale. Furthermore, the researchers focused solely on user behavior and did not include in-depth technical analysis of energy consumption by devices used in the campus environment. This study contributes by providing an understanding of the importance of green computing as an efficiency movement in educational institutions, particularly on campuses.

Acknowledgement

The authors would like to express their sincere gratitude to all parties who have provided support throughout the preparation of this research. Special thanks are extended to the supervising lecturer who provided guidance, direction, and invaluable input throughout the research process. The authors also thank the respondents who willingly took the time to complete the questionnaires, enabling this research to be conducted successfully. Appreciation is also extended to the university and all parties who assisted, both directly and indirectly, in the completion of this research.

References

[1.] P. M. Rosantika, G. Fatona, R. S. Juwito, R. Sari, M. Pratimi, and A. Y. Pratama, "Study on Planning and Development of Universitas Muhammadiyah Bengkulu as a Green Campus," Mutiara J. Ilm. Multidisiplin Indones., vol. 3, no. 1, pp. 151–166, 2025.
[2.] M. Sari, S. U. Lestari, and R. Awal, "Improving Students' Skills in Organic Waste Management to Realize Green Campus at Universitas Lancang Kuning," Lemb. Penelit. dan Pengabdi. Kpd. Masy., vol. 2, no. 2, pp. 193–196, 2018.
[3.] N. Nabila, Z. Zhafira, and E. Sumarni, "Technological Innovation in E-Business: Solutions for Energy Efficiency and Carbon Emission Reduction," J. Inspirasi Ilmu Manaj., vol. 3, no. 2, pp. 90–97, 2025.
[4.] M. Rusdan, "Planning for the Implementation of Green Computing in the General Computer Laboratory (LKU) of Universitas Widyatama Bandung," J. TEDC, vol. 11, no. 3, pp. 262–267, 2019.
[5.] N. N. Purnawan, R. Piarna, and R. Purwasih, "Analysis of Green Computing Implementation Strategy at Politeknik Negeri Subang," J. Ilm. Ilmu Dan Teknol. Rekayasa, vol. 1, no. 2, pp. 72–81, 2018.
[6.] T. A. Syahputri and Y. Amrozi, "Green Computing Implementation at the Faculty of Science and Technology, UIN Sunan Ampel Surabaya," SITEKIN J. Sains, Teknol. dan Ind., vol. 16, no. 2, pp. 142–146.
[7.] R. Y. Satria, R. M. A. Putra, M. Fadli, M. Dzikri, M. R. Al Fadhryy, and M. Encep, "Green Computing," Karimah Tauhid, vol. 2, no. 1, pp. 189–194, 2023.
[8.] A. Khumaidi, "Strategy for Green Computing Implementation and Campaign on Campus (Case Study: Universitas Krisnadwipayana)," in Proc. Natl. Seminar on Energy & Technology (SINERGI), 2018, pp. 223–230.
[9.] M. I. Farozi, D. Kurnia, and R. A. L. Aprilia, "Green Computing Planning Through Academic Document Digitization at ITS NUS Sumatera Selatan," in MDP Student Conference, 2023, pp. 596–603.
[10.] K. Jevanda and M. M. Livinus, "Analysis of Green Computing Implementation in Information Technology-Based Higher Education," J. Ilm. MATRIK, vol. 21, no. 3, pp. 184–193, 2019.
[11.] I. G. M. S. B. Pracasitaram and R. S. H. Linawati, "Concept and Implementation of Green Computing in the Campus Environment," Maj. Ilm. Teknol. Elektro, vol. 18, no. 3, p. 299, 2019.
[12.] W. Tegal et al., "Green Computing Implementation in Efforts to Improve Resource Efficiency at AMIK BSI Tegal," J. Khatulistiwa Inform., vol. 2, no. 1, p. 490768, 2016.
[13.] D. Haryanto, K. Karnadi, M. W. Perdan, J. Jimmei, and R. Febrin, "Implementation of Green IT to Improve Efficiency at PT. Djaja Sandjaja International," Jusikom J. Sist. Komput. Musirawas, vol. 6, no. 2, pp. 123–132, 2021.
[14.] H. Sulastri, "IT Strategy in Human Resource Information System (HRIS) to Achieve Green IT Strategy," JRSI (Jurnal Rekayasa Sist. dan Ind.), vol. 4, no. 02, pp. 199–204, 2017.
[15.] T. Hariyanti, "Analysis of Green Computing Technology Utilization in Supporting Educational Institution Management Performance," 2017.