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Research Paper

Strategic Formulation for Sustainable Campus Development: A SWOT-TOWS Analysis of Sebelas Maret University, Indonesia

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Abstract
Higher education institutions must implement appropriate evaluation and strategy determination to support their role in establishing a Sustainable Campus. This study aims to (1) evaluate the implementation of the sustainable campus program at Universitas Sebelas Maret (UNS), (2) analyze the dominance of internal (IFAS) and external (EFAS) factors at UNS, and (3) formulate strategies that UNS should implement to strengthen its sustainable campus initiatives-the implementation evaluation utilized data from the UNS GreenMetric report. The factor dominance analysis employed IFAS and EFAS, while the strategy formulation used SWOT-TOWS analysis. The findings indicate that UNS has stagnant scores in the Water (WR) and Transportation (TR) indicators. Furthermore, UNS's strengths lie in its open space availability and sustainable academic programs, though this advantage is hindered by limited budget allocation for toxic waste management. Based on the analysis, the recommended course of action for UNS is the Strengths-Opportunities (SO) strategy. The implementation of this SO strategy is necessary for UNS to advance its role as a sustainable campus successfully. This study implies that the integration of sustainability performance evaluation using UI GreenMetric data with IFAS, EFAS, and SWOT-TOWS analysis provides a structured basis for identifying dominant strategic conditions and formulating strength-oriented strategies to improve sustainable campus implementation at Universitas Sebelas Maret. The study implies that Universitas Sebelas Maret should utilize sustainability assessment results as strategic inputs rather than merely as reporting tools, enabling more targeted interventions in critical areas such as water and transportation management. These findings may further contribute to the development of management strategies derived from SWOT and TOWS analyses in other universities across Indonesia.

Keywords
Evaluation, Implementation, Sustainable Campus, Strategy, UNS

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1. INTRODUCTION

Higher education institutions play a crucial role in supporting the commitment to environmental friendliness through the concept of a Sustainable Campus. A sustainable campus refers to a higher education institution that systematically incorporates sustainability principles into governance, operations, education, research, and outreach activities. Furthermore, the concept of a sustainable campus emphasizes the integration of environmental principles into institutional management and the application of sustainable development practices within higher education institutions (Lozano et al., 2013).

The comparability and transparency of sustainability concepts across different universities often remain challenging, leading to a significant gap between student expectations and institutional public performance. Consequently, the establishment of a standardized framework became necessary (Lukács and Papp-Váry, 2024). One such standardized framework is the UI ranking. This ranking assesses sustainability performance based on six criteria: Settings and Infrastructure, Energy and Climate Change, Waste, Water, Transportation, and Education & Research (UI GreenMetric, 2023). Universitas Sebelas Maret (UNS) has participated in the UI GreenMetric since 2013 (UI GreenMetric, 2024b). UNS implements a contextual approach rooted in environmental culture and the utilization of green open spaces,

values that align with the characteristics of Surakarta as an urban center and Central Java as a semi-urban region (Soebagyo et al., 2013). However, the UI GreenMetric 2024 assessment for UNS reported sub-optimal performance in the Water (WR) and Transportation (TR) criteria, thereby necessitating a strategic analysis to enhance sustainability performance in these two specific areas (UI GreenMetric, 2024b; Universitas Sebelas Maret, 2024).

A SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) is a tool for determining a project's internal strengths and weaknesses, identifying available opportunities, and assessing the threats (Puyt et al., 2023; Teoli et al., 2025). Meanwhile, TOWS analysis (Threats, Opportunities, Weaknesses, Strengths) is an extension of the SWOT paradigm, specifically examining the matches between strengths and opportunities, and between threats and weaknesses (Maity et al., 2023). The combined SWOT-TOWS analysis can identify where improvements must be made to a system to achieve greater sustainability. In addition to the qualitative SWOT-TOWS, quantitative analysis methods like EFAS (External Factor Analysis Summary) and IFAS (Internal Factor Analysis Summary) are used to prioritize strategies based on external or internal factors. The use of both qualitative and quantitative methods is effective for formulating sustainable campus policy (Escalona et al., 2022; Gürel, 2017). However, research combining these methods within the context of sustainable campuses remains limited, often restricted to SWOT analysis alone.

Existing studies on sustainable campus development predominantly focus on descriptive assessments or single-year sustainability indicators, with limited attention to how longitudinal performance data can be systematically translated into strategic decision making (Sonetti et al., 2016; Filho et al., 2019; Munaro and John, 2025). There is a lack of studies that integrate multi year UI GreenMetric evaluation results into a structured framework combining SWOT, IFAS, EFAS, and TOWS analyses to identify indicator stagnation and develop prioritized sustainability strategies. Addressing this gap, the present study introduces an integrative evaluation-to-strategy approach that converts sustainability performance trends at Universitas Sebelas Maret.

This study aims to (1) evaluate the implementation of the sustainable campus program at Universitas Sebelas Maret (UNS), (2) analyze the IFAS and EFAS components for factor dominance at UNS, and (3) formulate strategies to enhance UNS's performance as a sustainable campus using the SWOT-TOWS analysis. The findings are expected to provide applicable strategic recommendations for improving UNS's sustainability performance, particularly concerning the Water (WR) and Transportation (TR) criteria, and serve as a guide for other higher education institutions facing similar challenges.

2. EXPERIMENTAL SECTION

2.1 Materials

The study was conducted at Universitas Sebelas Maret (UNS), Surakarta, Central Java, Indonesia, from March to November 2023. This research employed a mixed-methods approach, combining qualitative and quantitative analyses. Data collection was conducted using documentation, interviews, and observations. Documentation was carried out by collecting data from the UI GreenMetric reports for the period 2021-2024 and from Universitas Sebelas Maret SDGs report documents.

Interviews were conducted with two respondent groups: students and institutional stakeholders at Universitas Sebelas Maret. The stakeholders were interviewed to elicit comprehensive information regarding the vision, policies, implementation, challenges, opportunities, and the level of engagement of various parties in the sustainable campus program.

2.2 Methods

2.2.1 Assessment of Sustainable Campus Program Implementation at Universitas Sebelas Maret Based on UI GreenMetric Indicators

The evaluation focuses on identifying progress, stagnation, and constraints in program implementation based on indicator achievement trends. The evaluation was conducted by analyzing the scores obtained by UNS from the UI GreenMetric assessment reports spanning the years 2021-2024. The analysis involved calculating and comparing the scores from the six indicator criteria provided in the reports (Table 1). This evaluation served to determine the SWOT components inherent to UNS.

Table 1. Categories are Used in UI GreenMetric Rankings (UI GreenMetric, 2024a)

Category	Percentage of Total Points (%)
Setting and Infrastructure (SI)	15
Energy and Climate Change (EC)	21
Waste (WS)	18
Water (WR)	10
Transportation (TR)	18
Education and Research (ED)	18
Total	100

2.2.2 Analysis of IFAS and EFAS Components

The analysis of the IFAS (Internal Factor Analysis Summary) and EFAS (External Factor Analysis Summary) components was performed using data derived from interviews with students and stakeholders. The study population consisted of active students at Universitas Sebelas Maret. The sample size was determined using a random sampling technique.

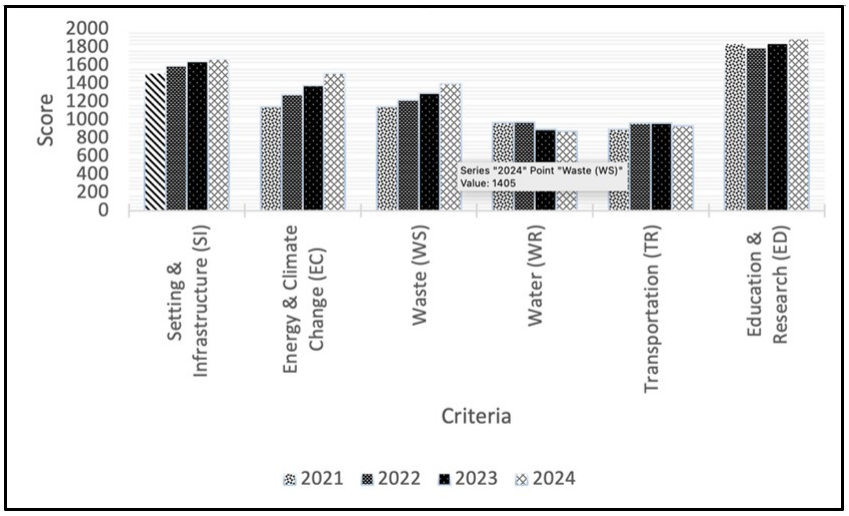

Figure 1. UI Greenmetric UNS Assessment Graph for 2021-2024. The Total UNS Score Increased from 7,550 (2021) to 8,320 (2024)

For the determined EFAS and IFAS components, each factor was assigned a weight score (0.05-0.15) reflecting its significance to the program's success, and a performance score (1-4) illustrating the factor's influence on the response of Sustainable Campus facility users (Table 2) (Rangkuti, 2013). The weight score was multiplied by the performance score to obtain the individual factor score.

Table 2. Weighted Scores and Performance Scores on IFAS and EFAS Analysis

Weighted Score		Performance Score	
Score	Description	Score	Description
0.05	low influence	1	very ineffective performance
0.10	medium influence	2	less effective performance
0.15	huge influence	3	effective performance
		4	very effective performance

The weighting and rating of the IFAS and EFAS matrices were determined using the Expert Judgment technique. The assessors were selected purposively and consisted of UNS greencampus team and environmental experts. To ensure the consistency and objectivity of the results, the assessment process was carried out through focus group discussions to reach a consensus. In addition, the scoring was based on objective data from the UI GreenMetric reports from 2021 to 2024, combined with field observations, so that the subjectivity of the assessment could be minimized.

2.2.3 SWOT-TOWS Analysis for Formulating Strategies to Enhance UNS's Sustainable Campus Performance

The identification of the strengths, weaknesses, opportunities, and threats of Universitas Sebelas Maret was derived from UI GreenMetric report documents and field observations. The procedures for data compilation and matrix construction were conducted in accordance with Oktari et al. (2023) and Weihrich (1982) (Table 3).

3. RESULT AND DISCUSSION

3.1 Evaluation of UNS Sustainable Campus Program Implementation

Based on the UI GreenMetric assessment, UNS demonstrates a consistent commitment to sustainability from 2021 to 2024. UNS's overall Sustainable Campus score has increased significantly over the last three years, rising from 7,550 in 2021 to 8,320 in 2024 (Figure 1). The work programs implemented by UNS are detailed in Table 4 and Figure 2. This UI GreenMetric report data was used to formulate UNS's SWOT components (Table 5).

Score improvements were observed across four criteria: Setting and Infrastructure (SI), Energy and Climate Change (EC), Waste (WS), and Education and Research (ED). The score increase in the SI criterion is supported by the campus area size of 4.6 million m^2, with more than 35% designated as forest vegetation. The score increase in the EC criterion is supported by the rising solar energy production, from 726,244 kWh to 866,404 kWh, and the expansion of smart buildings, from 159,543 m^2 to 266,651 m^2. However, the renewable energy ratio remains within the 2-25% range, signaling the need for further energy conservation efforts to reach maximum potential. The increase in the WS criterion is supported by the improved processing of organic and

inorganic waste, which rose from the >25-50% range to the >75-85% range. However, toxic waste management still requires reinforcement. The score increase in the ED criterion is supported by the rising number of sustainability courses, which has reached 3,275; however, the score cannot increase substantially due to having reached the maximum limit.

In contrast to the improvements, a decrease in score was observed in two criteria in 2024: Water (WR) and Transportation (TR). The score reduction in the WR criterion is attributed to the persistently increasing campus population pressure, which has not been proportionally matched by wastewater management capacity. Meanwhile, the score reduction in the TR criterion is primarily driven by a surge in the number of motorcycles, from 11,820 to 25,430 units, which consequently hinders significant progress in this criterion. In the Water (WR) criterion, several programs have been implemented, including the construction of 117 infiltration wells out of a 300-unit target (increasing infiltration by 48.88%), the optimization of >500 biopore holes (since 2015-2019) for rainwater absorption and organic waste processing, the utilization of the UNS lake (1.206 ha area, 7,959 m^3 volume) to maintain groundwater balance, and the monitoring of surface water discharge at 179.90 m^3/month (Wiwoho et al., 2021). The use of lakes as a water source at universities has also been implemented by Universitas Indonesia (Hidayat and Dewi, 2022). However, further efforts are needed, including optimizing the utilization of unused water capacity, replacing overcapacity pumps with smaller ones for energy efficiency, improving water distribution management (such as pipeline network analysis, HDPE pipe maintenance, and Waternet 2.2 simulation), enhancing water quality assurance (such as periodic water content testing, reservoir and dispenser cleaning, and additional filtration), better managing water needs data, and expanding cooperation with PDAM (Local Water Company) and the campus SPAM (Water Supply System) model (Setiawan et al., 2018).

Hidayat and Dewi (2022) identify three key parameters in water management: social, economic, and environmental aspects. Water management in university settings should adopt sustainable eco-efficiency principles, including reducing the water footprint through minimizing meat consumption, substituting coffee with tea, prioritizing locally produced goods, and reducing the intake of processed products (Reset, 2018; Hidayat and Dewi, 2022). This analysis provides a basis for recommending water footprint management strategies at Universitas Sebelas Maret. Social approaches, including promotional messages and communication campaigns, should be considered to enhance students' awareness within the Universitas Sebelas Maret environment. Gherheş and Cernicova-Buca (2025) demonstrated that persuasive campaigns effectively reduced shower duration and improved laundry practices in student dormitories, indicating that non-technological interventions can significantly support water management among university students. In the Transportation (TR) criterion, despite a significant decrease in the number of incoming cars (from 1,938 to 1,124 units), the increased use of motorcycles is the main barrier to progress. For this criterion, UNS provided 134 emission-free vehicles in 2024 (Figure 2c). Despite the availability of zero emission vehicles, the vehicle to population ratio on campus remains a challenge for Universitas Sebelas Maret, along with limited parking reduction initiatives and the lack of automated monitoring and evaluation.

Suboptimal transportation system management in campus environments is not limited to Universitas Sebelas Maret. **?** report shows that out of 1,745 universities worldwide participating in the ranking, only the University of Bologna, Italy, achieved a perfect score in the transportation component. In managing campus transportation, the University of Bologna adopts a sustainable mobility approach within its multi campus territorial structure. The policies implemented include strengthening public transportation, developing cycling facilities, utilizing electric or hybrid vehicle fleets, and improving pedestrian accessibility (Battistini et al., 2021). In Indonesia, Universitas Diponegoro (UNDIP) is reported to have the best campus transportation management, achieving a score of 97%. UNDIP prioritizes campus bus services through route development, service quality improvement including bus stops and operating hours, and the use of monitoring applications to support transportation management (Murti et al., 2024).

On the other hand, Universitas Indonesia, recognized as the leading green campus in Indonesia, integrates policy and infrastructure approaches in campus transportation management. The university restricts private vehicle use through the development of pedestrian pathways, dedicated motorcycle lanes via the Bikers Outer Ring Road, gate parking systems, and regulations prohibiting first year students from bringing private cars onto campus (Kiswanto et al., 2021). Overall, UNS has made substantial efforts to realize a sustainable campus. However, water and transportation management require specific strategic improvements to optimize the sustainable campus performance. Based on the UI GreenMetric assessment, UNS has shown substantial efforts in realizing a sustainable campus; nevertheless, the WR and TR criteria still require special attention.

3.2 Analysis of IFAS and EFAS Components

In the IFAS (Internal Factor Analysis Summary) factor, the Strengths (S) component obtained a score of 2.70, while the Weaknesses (W) component received a score of -0.50. The summation of these two scores yielded a result of 2.20 (Table 6). Conversely, in the EFAS (External Factor Analysis Summary) factor, the Opportunities (O) component reached a total score of 2.70, while the Threats (T) component obtained a total score of -0.50. The summation of these scores also resulted in 2.20 (Table 7).

The resulting sum scores are used as coordinates in the IFAS-EFAS quadrant. With the coordinates (2.20; 2.20),

Figure 2. Various Facilities that Support a Sustainable Campus at UNS, (a) Waste Management (Organic and Inorganic), (b) Wastewater Storage for Ablution, (c) Emission-Free Vehicles, (d) Infiltration Wells, (e) Wastewater Treatment Installations, and (f) Green Open Spaces

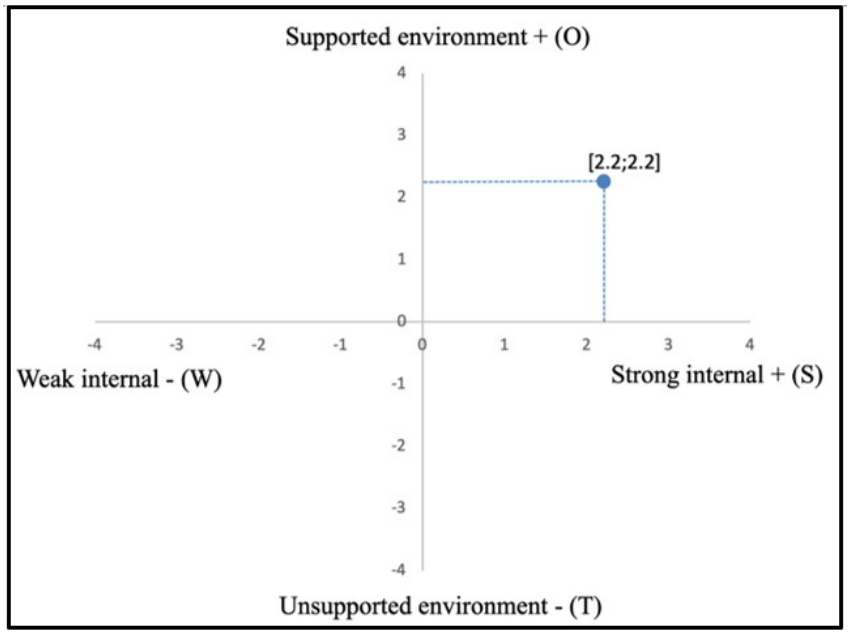

Figure 3. UNS's Position in the IFAS-EFAS Quadrant, is in a Strong Internal Position (S) and a Supported Environment (O)

Table 3. TOWS Strategy Matrix for Sustainability Program Enhancement Campus

Quadrant	Strategy criteria	Description
I	SO (Strength – Opportunity)	Utilise strength, internal use reach opportunity, external
II	ST (Strength – Threats)	Utilize your inner strength to overcome external threats
III	WT (Weakness – Threats)	Overcome weakness internally for the sake of utilising the opportunity externally
IV	WO (Weakness – Opportunity)	Minimize weaknesses, internal use, and avoid threats, both external and internal

UNS's position in the IFAS-EFAS quadrant is determined to be in Quadrant I (Figure 3). This quadrant signifies a combination of strong internal factors (S) and a supported external environment (O). The SO strategy (Strength-Opportunity) is a proactive approach. This means that the internal environment contains strengths that are more dominant than weaknesses, and the external environment contains opportunities that are more dominant than threats. This strategy involves utilizing opportunities and strengths to the maximum extent, thereby achieving dynamic growth (Kowalik and Klimecka-Tatar, 2017). Organizations in this position are encouraged to be proactive, innovative, and expand their operational scope. This is not the time to be defensive or play it safe; instead, it is a chance to capitalize on the momentum. This position can create significant competitive advantages (Septiani, 2022). This strategy represents a substantial expansion and diversified growth strategy (Skotnicka-Zasadzień and Grebski, 2023).

3.3 SWOT-TOWS Analysis for Formulating Strategies to Enhance UNS's Sustainable Campus Performance

Based on the IFAS-EFAS quadrant, UNS is positioned in Quadrant I. The necessary strategy that UNS must implement to enhance its Sustainable Campus performance is the Strengths-Opportunities (SO) strategy. Consequently, the SO strategy plan has been formulated in the TOWS matrix (Table 8).

In this advantageous position, UNS needs to leverage its internal strengths to capitalize on external opportunities. UNS's internal strengths include extensive green infrastructure, effective waste management, academic excellence in sustainability, implementation of renewable energy, and innovative ablution water management. These strength components enable UNS to optimally leverage external opportunities, such as government policy support for renewable energy, the global trend toward sustainable higher education, the potential for broad international collaboration, rising public demand for green campuses, and technological innovations in waste management.

Based on Table 8, the strategies that UNS can undertake to enhance its performance as a Sustainable Campus include: 1) Increasing solar energy capacity (S4) by utilizing government policy (O1) for greater energy efficiency; 2) Developing more sustainability courses (S3) to meet global trends (O2) and enhance academic reputation; 3) Expanding international collaboration (O3) by leveraging academic excellence (S3) to yield more publications (targeting >300 annually); 4) Promoting extensive vegetation (S1) to meet competitor demands (O4) and reinforce the green campus image; 5) Adopting new waste technology (O5) to improve waste management efficiency (S2), including organic/inorganic waste.

3.3.1 Increasing Solar Energy Capacity (S4) by Utilizing Government Policy for Greater Energy Efficiency (O1)

UNS's strength in solar panel integration can be further leveraged through support from renewable energy policies. National policies promoting the implementation of green energy offer incentives, such as subsidies or regulations, that support the expansion of solar panel infrastructure. This strategy aims to increase UNS's renewable energy ratio, which is currently limited (2-25%), thereby reducing dependence on fossil fuels and supporting national sustainability targets. Actionable programs include increasing the capacity of the Photovoltaic (PV) system-the conversion of sunlight into electrical energy. Furthermore, integrating an Energy Storage System (Battery Storage) to store surplus PV energy for use when needed is essential to enhance energy efficiency and availability. Methods to increase solar panel integration involve optimizing PV energy charging times, expanding charging infrastructure, and collaborating on national energy policies (Chowdhury et al., 2018).

Increased building energy efficiency can be achieved through optimizing building envelope components, such as wall insulation, argon-filled double-glazing windows, and low U-value doors. Other steps include replacing all lighting with high-efficiency LEDs, utilizing electrical equipment with the highest energy ratings, installing high-efficiency condensing boilers (85% efficiency) with advanced controls, and increasing Renewable Energy Sources (RES) by installing high-capacity solar panels (550 W, 21.6% efficiency) on rooftops and parking areas. Providing adequately sized

Table 4. UNS Work Programs that Support the Campus' Commitment to Sustainability

Criteria	Program Implementation
Settings and Infrastructure (SI)	Management of 4.6 million m^2 of campus infrastructure, maintaining more than 90–95% of green open space, and maintaining more than 35% of forest vegetation for ecological balance (Figure 2f).
Energy and Climate Change (EC)	Renewable energy production, development of energy-efficient buildings, diversification of energy sources, increased electricity efficiency with solar power production reaching 866,404 kWh (2024), and a bright building area of 266,651 m^2, which supports emission reductions.
Transportation (TR)	Provision of low-emission transportation facilities such as campus buses, bicycles, and emission-free vehicles, as well as a policy to control private vehicles, with 134 emission-free vehicles available by 2024 for students and educators (Figure 2f).
Waste (WS)	Organic and inorganic waste recycling, toxic waste reduction, and waste reduction initiatives, which successfully processed over 75–85% of organic waste (213 tons) and inorganic waste (210.4 tons) by 2024, supported by segregated waste bins and composters (Figures 2a and 2e).
Water (WR)	Collection and reuse of ablution wastewater for plant watering as a water conservation effort, liquid waste treatment, and development of infiltration infrastructure with a water recycling rate of >50% (Figures 2b and 2d).
Education and Research (ED)	Integration of sustainability courses into the curriculum, and increasing the number of research and scientific publications to more than 300 annual publications.

Table 5. UNS SWOT Components as Campus Sustainable

Strengths (S)	Weaknesses (W)	Opportunities (O)	Threats (T)
Extensive green infrastructure	Limited toxic waste management	Government policy support for renewable energy	Strict environmental regulations
Effective waste management system	Reliance on private vehicles	Global trends in sustainability in higher education	Climate change exacerbates water scarcity
Academic excellence in sustainability	Limited water management	International collaboration for sustainability research	Competition with other universities in sustainability
Solar panel integration for energy savings		Public demand for green campuses	
Efficient ablution water management		Innovation in waste management technology	

electric vehicle charging stations and implementing innovative charging strategies that utilize PV production should also be adopted (Movlyanov and Selçuklu, 2025). In this regard, UNS should expand PV usage to meet 50% of its total energy demand.

3.3.2 Developing More Sustainability Courses (S3) to Meet Global Trends (O2) Aims to Enhance Academic Reputation

UNS currently offers 3,275 sustainability courses. Although this program has earned UNS the maximum score in the Education and Research (ED) criterion, it must be maintained and further enhanced to maintain its competitive edge. Curriculum expansion and the provision of more sustainability courses are necessary to attract international students and lecturers, as well as to improve the university's ranking in global indices. These sustainability courses should be accessible across faculties, covering topics such as the green economy, biodiversity conservation, sustainable agricultural systems, and sustainable transportation technology. Integrating plant conservation topics into cross-disciplinary curricula is necessary to enhance student awareness of envi-

Table 6. UNS Sustainable Campus IFAS Scores

Internal Strategic Factors	Weight (W)	Performance (P)	W×P	Comment
Strengths (S)				
Extensive green infrastructure	0.15	4	0.60	The 4.6 million m^2 campus, featuring over 35% forest vegetation and more than 10–20% plant vegetation, as illustrated in Figure 2(f), supports biodiversity and ecological balance.
Effective waste management system	0.15	4	0.60	Organic waste processing of over 75–85% (213 of 224.29 tons) and inorganic waste of over 65–85% (210.4 of 259.53 tons) by 2024 is supported by segregated waste bins and composters.
Academic excellence in sustainability	0.15	4	0.60	Sustainability courses increased from 2,750 (2023) to 3,275 (2024), and there are more than 300 annual publications, further promoting environmental awareness.
Solar panel integration for energy savings	0.15	3	0.45	Solar power production of 866,404 kWh and smart buildings of 266,651 m^2 (as of 2024) demonstrate a commitment to green energy, although the renewable energy ratio remains limited, at over 2–25%.
Efficient ablution water management	0.15	3	0.45	Ablution wastewater management supports water recycling of over 50% (as of 2024), although the use of water-saving equipment remains limited.
Sub-total	0.75		2.70	
Weaknesses (W)				
Limited toxic waste management	0.10	2	0.20	A 70% reduction in toxic waste has been achieved; however, the limited availability of dedicated treatment facilities hinders comprehensive waste management.
Reliance on private vehicles	0.10	2	0.20	The increase in motorcycle use from 11,820 (2023) to 25,430 (2024) and low shuttle bus utilization (average of 7 passengers) hinder green transportation, despite the availability of bicycle parking.
Limited water management	0.05	2	0.10	Water recycling is greater than 50%, and absorption wells, as shown in Figure 2(d), are present; however, the lack of water-saving equipment and the pressure of building expansion (357,163 m^2) limit conservation.
Sub-total	0.25		0.50	
TOTAL	1.00		2.20	

ronmental conservation (Shange et al., 2025).

Enhancement of the ED criterion can be achieved by integrating sustainability into the curriculum and offering experience-based learning. Significant improvement in research is also required, which can be achieved by establishing sustainability research centers, expanding research partnerships, allocating funds for research and publications, and integrating education with research through student projects and combined facilities (Shange et al., 2025). The provision of sustainable courses is interdisciplinary; knowledge in one field can be extended to others. For instance, chemical engineers working on sustainable jet fuel may end up as policymakers or managers in the aviation industry focused on sustainable fuel management. Based on this, most courses

Table 7. UNS Sustainable Campus EFAS Scores

External Strategic Factors	Weight (W)	Performance (P)	W×P	Comment
Opportunities (O)				
Government policy support for renewable energy	0.15	4	0.60	National policy promotes renewable energy, supporting increased solar power production at UNS (866,404 kWh by 2024) and strengthening energy efficiency.
Global trends in sustainability in higher education	0.15	4	0.60	Global trends are driving the development of a sustainability curriculum, in line with UNS's 3,275 sustainability courses (2024), thereby enhancing its academic reputation.
International collaboration for sustainability research	0.15	4	0.60	Ten international collaborations support over 300 annual UNS publications, expanding the global impact of sustainability research.
Public demand for green campuses	0.15	3	0.45	The community expects a sustainable campus, supporting UNS's extensive vegetation (∼1.18 million m^2), as seen in Figure 2(f), although transportation (25,430 motorcycles) is less supportive.
Innovation in waste management technology	0.15	3	0.45	New technologies can improve toxic waste treatment (70% by 2024), complementing organic and inorganic waste management.
Sub-total	0.75		2.70	
Threats (T)				
Strict environmental regulations	0.10	2	0.20	Strict regulations demand better toxic waste management, while UNS's facilities are limited (70% by 2024).
Climate change exacerbates water scarcity	0.10	2	0.20	Climate change is increasing pressure on water resources, while UNS has limited water-saving equipment, despite recycling over 50% of its water.
Competition with other universities in sustainability	0.05	2	0.10	Other campuses with greener transportation are challenging UNS, which still relies on motorcycles (25,430 units by 2024), despite bicycle parking.
Sub-total	0.25		0.50	
TOTAL	1.00		2.20	

in science, engineering, business, and even the humanities have integrated sustainable study elements (Dawodu et al., 2022). Integrating sustainability into the higher education curriculum reflects a commitment to fostering sustainable development and equipping future generations with the skills and knowledge to address pressing environmental challenges (Abo-Khalil, 2024).

3.3.3 Expanding International Collaboration (O3) with Academic Excellence (S3) is Designed to Generate More Publications (>300 Annually)

Continuous improvement is necessary for increased international collaboration in teaching, research, and publications. Furthermore, the formation of international consortia related to Sustainable Campus initiatives can also be pursued (Budihardjo et al., 2021). Collaboration can significantly influence citation counts; a high number of citations is often associated with international collaboration, as it enhances the paper's visibility and connectivity. Additionally, international collaboration involves contributions from numerous individuals with diverse experiences and backgrounds, resulting in more thorough and detailed research. This higher-quality research attracts the attention of other stakeholders and garners more citations. International research collaboration emphasizes quality, and collaborating with other authors enhances a paper's impact within the academic community (Alamah

Table 8. SWOT–TOWS Matrix Based on SWOT Diagram

EFAS / IFAS	Strength (S)	Weakness (W)
	1. Extensive green infrastructure 2. Effective waste management system 3. Academic excellence in sustainability 4. Integration of solar panels for energy savings 5. Efficient ablution water management	1. Limited toxic waste management 2. Dependence on private vehicles 3. Limited water management
Opportunities (O)	SO strategy	WO strategy
1. Government policy support for renewable energy 2. Global sustainability trends among major competitors 3. International collaboration for sustainability research 4. Competitor demand for green campuses 5. Innovation in waste management technology	1. Increase solar power capacity (S4) by leveraging government policies (O1). 2. Develop more sustainability courses (S3) to meet global trends (O2). 3. Expand international collaboration (O3) with academic excellence (S3). 4. Promote extensive vegetation (S1) to meet competitor demand (O4). 5. Adopt new waste technologies (O5) to improve waste management efficiency (S2).	1. Adopt new waste technologies (O5) to address toxic waste limitations (W1). 2. Leverage global trends (O2) to promote green transportation policies (W2). 3. Leverage government policy support (O1) to adopt water-saving equipment (W3).
Threats (T)	ST strategy	WT strategy
1. Strict environmental regulations 2. Climate change worsening water scarcity 3. Competition with other universities in sustainability	1. Leverage academic excellence (S3) for waste research to meet regulations (T1). 2. Utilize ablution water management (S5) to mitigate water scarcity (T2). 3. Promote extensive vegetation (S1) to maintain competitiveness (T3).	1. Reduce reliance on private vehicles (W2) to comply with regulations (T1) and competitiveness (T3). 2. Increase water-efficient equipment (W3) to address climate-change-driven water scarcity (T2).

et al., 2023).

3.3.4 Promoting Extensive Vegetation (S1) to Meet Public Demand (O4) Aims to Strengthen the Green Campus Image

UNS has undertaken efforts to enhance its green campus image in response to public demand. The continuously improving work programs aim to increase public awareness regarding ecological balance. Plant conservation can be conducted to support sustainability courses as a cross-disciplinary science (Shange et al., 2025). UNS has implemented plant conservation through a policy of felling one old tree that poses a danger and replacing it with five new trees. Furthermore, the "one student, one tree" program has been initiated for new students, where tree planting is a mandatory agenda item during orientation. This initiative can enhance students' understanding and awareness of environmental sustainability and foster responsible environmental behaviors from the early stages of their academic experience (Barth et al., 2007). Plant conservation is further supported by the construction of an orchid conservation facility, known as the "Orchidarium," and the "UNS Arboretum," a conservation area that contains rare plants, flowering plants, and fruit-bearing plants, all of which are designated to support nectar- and fruit-eating animals, thereby forming a balanced ecosystem at UNS. Additionally, UNS possesses a lake that supports ecological and vegetation conservation. Animal conservation is also implemented through the development of the Bali Starling conservation area, named the "Bird Conservatory." UNS also has educational forests spread across several areas in Central Java to support sustainability courses. Planning for an Edupark program is currently underway to enhance educational and conservation goals. Campuses are expected to maintain biodiversity conservation, featuring native plants, medicinal plants, flowering plants, and fruit plants that attract insects and fruit-eating

animals. The campus environment should also include shade trees equipped with open water sources to create a balanced on-campus ecosystem (Rajalakshmi et al., 2022).

3.3.5 Adopting New Waste Technology (O5) to Increase Waste Management Efficiency (S2) Offers Innovative Solutions

UNS's waste management system needs enhancement through technological innovation, particularly for handling toxic waste. Technologies such as bioreactors can be implemented to mitigate environmental impact. Efforts to improve waste management performance include adding recycling infrastructure, reducing single-use packaging, increasing education and sustainable communication campaigns, and developing more integrated waste management policies (Tangwanichagapong et al., 2017). Waste treatment using the gasification method can be recommended. This method offers high efficiency and lower emission impacts compared to other waste combustion techniques. The gas produced from the gasification process is then used to run a gas generator engine, which subsequently supplies electricity to the campus, thereby advancing renewable energy development (Pawenary et al., 2023). Furthermore, organic waste can be processed into biofuel and biogas using tools like a biodigester. This system operates on the principle of placing organic materials in an anaerobic condition, allowing the organic waste to be fermented by methanogenic bacteria to produce biogas (Kumaat et al., 2023). The results of this study have strategic implications for green campus management in Indonesia, particularly in shifting the assessment paradigm from mere administrative reporting to data-driven decision-making. The UNS shows that the use of the IFAS-EFAS matrix integrated with UI GreenMetric data enables universities to identify points of stagnation with precision. This is in line with Munaro and John (2025) and research trends in Southeast Asia, which now emphasize management frameworks and student involvement in sustainable practices (Rizal and Nawanir, 2025). For other universities in Indonesia, this study emphasizes the importance of synchronizing government policies on renewable energy with campus infrastructure development (Chowdhury et al., 2018).

Operationally, the success of a sustainable campus requires the integration of facility management and academic research (Sonetti et al., 2016). This can be reinforced by fostering a culture of sustainability across the university system, where sustainability principles are integrated into institutional policies, curriculum design, and academic activities as part of the institutional vision and mission (Lozano et al., 2013). However, campus managers may rely solely on top-down policy. As emphasized by Działek et al. (2025), bottom-up initiatives and the active involvement of the campus community in organizing academic green spaces are crucial for addressing socio-ecological challenges in the university environment. In a global context, this study reinforces the position of universities as "living laboratories" for sustainable development. The implementation of the Strengths-Opportunities (SO) strategy enables universities to demonstrate low-carbon practices through interdisciplinary curricula and smart energy management (Filho et al., 2019). Overall, the transformation towards a sustainable campus requires a balance between nature conservation, technological innovation, and strategic leadership capable of turning environmental challenges into competitive institutional advantages (Munaro and John, 2025; Rizal and Nawanir, 2025).

4. CONCLUSIONS

Universitas Sebelas Maret (UNS) maintains a consistent commitment to integrating the concept of a Sustainable Campus. Out of the six assessment criteria, two criteria require maximal effort for improvement: Water (WR) and Transportation (TR). The necessary strategy that UNS must implement to enhance its sustainable campus performance is the strengths and opportunities strategy, which involves leveraging internal strengths to seize external opportunities. Five key efforts that UNS must undertake are: 1) Increasing solar energy capacity (S4) by utilizing government policy (O1) for greater energy efficiency; 2) Developing more sustainability courses (S3) to meet global trends (O2) and enhance academic reputation; 3) Expanding international collaboration (O3) by leveraging academic excellence (S3) to yield more publications; 4) Promoting extensive vegetation (S1) to meet competitor demands (O4) and strengthen the green campus image; 5) Adopting new waste technology (O5) to increase waste management efficiency (S2), including both organic and inorganic waste.

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