Strengthening the Green University Ecosystem through the Six Indicators of UI Greenmetric

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Abstract. The development of a green university is a crucial strategy for realizing sustainable and environmentally conscious higher education. The University of Indonesia Greenmetric (UIGM) is a global instrument used to measure university performance in sustainability management through six key indicators: (1) setting and infrastructure (SI), (2) energy and climate change (EC), (3) waste (WS), (4) water (WR), (5) transportation (TR), and (6) education and research (ER). This article aims to explore UIGM indicators reflect the university's progress toward becoming a green university and to analyse the strategies for strengthening the green university ecosystem by referring to these six indicators. The research method used a qualitative approach with document studies, policy analysis, and interviews with Green Campus program managers. The study results indicate that strengthening the green university ecosystem requires cross-sector collaboration, curriculum integration, technological innovation, and the active participation of the academic community. Recommendations include optimizing environmentally friendly infrastructure management, energy efficiency, integrated waste management systems, water conservation, low-emission transportation, and increasing research and education related to sustainability.

1 Introduction

Sustainability is currently a major global concern, in line with increasingly pressing environmental issues such as climate change, ecosystem degradation, pollution, and limited natural resources [1]. Higher education plays a strategic role in addressing these challenges, not only as a centre for scientific development, but also as an agent of social, cultural, and environmental change. Therefore, the concept of a green university has emerged as a model for higher education that focuses not only on teaching and research but also on sustainable environmental management within the campus [2, 3].

Teaching and research are now not only academic products but also instruments for achieving sustainability, with an impact measurable through the university's position in global sustainability rankings [4, 5]. In Indonesia, one important initiative pushing

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universities towards sustainability is the UI Greenmetric (UIGM) World University Ranking, initiated by the University of Indonesia in 2010. This initiative assesses universities worldwide based on six key indicators: (1) setting and infrastructure (SI), (2) energy and climate change (EC), (3) waste (WS), (4) water (WR), (5) transportation (TR), and (6) education and research (ER). These six indicators reflect important dimensions of the sustainability ecosystem in higher education, ultimately enhancing not only the university's reputation but also having a tangible impact on the surrounding community and environment.

Although many universities in Indonesia have participated in the UIGM rankings, the challenges in strengthening a green university ecosystem remain significant. These issues include limited funding for environmentally friendly infrastructure, low academic participation, a lack of integration of sustainability into the curriculum, and suboptimal transportation and waste management policies. This demonstrates that simply participating in the rankings is not enough; a more comprehensive and sustainable strategy is needed to strengthen the green university ecosystem.

This study is relevant because it discusses how universities can strengthen their green ecosystems by referring to the six main indicators of UIGM. With in-depth analysis, it is hoped that practical strategies can be identified that Indonesian universities can adopt to improve sustainability performance while supporting the achievement of the Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), and SDG 13 (Addressing Climate Change). Therefore, this study aims to answer the following questions:

1. How do UIGM's six indicators reflect progress towards becoming a green university?
2. What is the university's strategy for strengthening the green university ecosystem?

2 Theoretical Framework

2.1 The Green University Concept

The concept of a green university as living laboratories, where students, faculty, and the community learn and practice sustainability [6]. There are three main dimensions of a green university: (a) Ecological dimension: encompasses the management of natural resources, energy, water, and waste; (b) Academic dimension: encompasses the integration of sustainability into the curriculum, research, and scientific publications; and (c) Social dimension: relates to the participation of the academic community and community involvement in environmental issues. Thus, a green university focuses not only on environmentally friendly infrastructure but also on creating a culture of sustainability.

2.2 UI Greenmetric (UIGM) World University Ranking

UIGM is a university ranking system that assesses higher education institutions' commitment to sustainability. UIGM is not only a ranking instrument but also a driving force to encourage universities to adopt sustainable policies more seriously [7]. Launched in 2010, Greenmetric now counts over 900 universities from various countries.

The six main indicators of UI Greenmetric are:

a) SI – the availability of green open spaces, campus layout, and infrastructure support.
b) EC – energy efficiency, renewable energy use, and the university's contribution.
c) WS – solid and liquid waste management, recycling, and plastic waste reduction policies.
d) WR – water conservation, the use of water-saving technologies, and water quality.
e) TR – environmentally friendly transportation systems, restrictions on private vehicles, and bicycle and pedestrian facilities.

f) ED – the integration of environmental issues into the curriculum, research, publications, and student activities.

2.3 Green Universities and the Sustainable Development Goals (SDGs)

University involvement in sustainability is closely linked to the SDGs. Some relevant goals are SDG 4 to ensuring quality education by embedding sustainability values in the curriculum, SDG 11 to universities as models of sustainable communities that can be adopted by surrounding cities, SDG 12 to implementing principles of efficient consumption of energy, water, and waste management, SDG 13 to universities as agents of climate change mitigation through clean energy research and innovation. Furthermore, integrating sustainability into higher education strengthens the role of universities not only as knowledge providers but also as catalysts for social transformation towards a more sustainable society [8].

3 Research Method

This research uses a descriptive qualitative approach with the aim of delving deeply into the strategies, challenges, roles of the academic community, and recommendations for strengthening the green university ecosystem based on the six UIGM indicators. The research location was selected at one of the Indonesian universities participating in the UIGM rankings. The research subjects included Green Campus managers or special units handling Greenmetric, lecturers active in research and teaching on sustainability issues, students involved in environmental communities, and educational staff involved in campus facility management. Subjects were selected purposively, considering their direct involvement in the implementation of the six UIGM indicators.

Data collection was conducted using three main techniques. First, a document study included an analysis of UIGM annual reports, university policy documents related to the environment, and sustainability work programs. Second, in-depth interviews were conducted with administrators, lecturers, students, and staff, focusing on four areas: green university strengthening strategies, implementation challenges, academic community participation, and recommendations for improvement. Third, participant observation was conducted on campus to observe actual practices, such as green open space management, energy systems, environmentally friendly transportation, and student activities that support sustainability.

Data analysis was conducted using thematic analysis. The analysis process began with coding the collected data according to the six UIGM indicators. The data was then grouped into broad themes: strategies, challenges, the role of the academic community, and recommendations. The findings were then interpreted by connecting them to green university theory, the concept of sustainability, and their relevance to the SDGs.

To ensure data validity, this study utilized triangulation of sources, methods, and theories. Source triangulation was conducted by comparing interview results from various actors (lecturers, students, and staff). Method triangulation was conducted by comparing data from document studies, interviews, and observations. Meanwhile, theoretical triangulation was conducted by linking field findings with literature on green universities, UIGM, and sustainable development. This way, the data obtained is more credible and can provide a comprehensive picture of strengthening the green university ecosystem.

4 Results and Discussion

Based on the results of document studies, interviews, and observations at the university that served as the focus of this research, it was found that strengthening the green university

ecosystem has been carried out using various strategies that refer to the six UIGM indicators. Figure 1 illustrates the University sustainability scores among six indicators. However, implementation in the field still faces a number of structural, cultural, and technical challenges. These findings can be explained in more detail as follows.

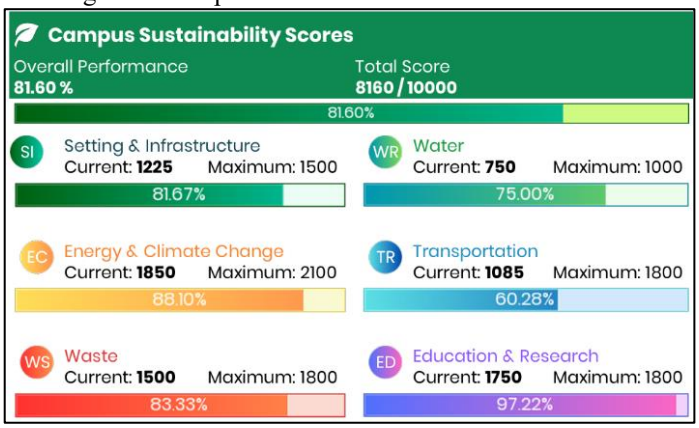

Fig. 1. University sustainability scores.

4.1 Setting and Infrastructure (SI)

According to the green campus manager, "*the university has allocated a significant amount of green open space, including park areas, pedestrian paths, and environmentally friendly public spaces*". This demonstrates an initial commitment to supporting a green ecosystem. However, interviews revealed that limited land in several faculties presents a barrier to expanding green space. Furthermore, "*the role of the academic community is also still limited to symbolic tree planting activities, which have not yet become a shared culture*". The strategy university is to develop a more comprehensive green space policy and encourage active student participation in campus environmental maintenance [9]. Figure 2 indicates Indicator and scores of settings and infrastructure, while Figure 3 demonstrate the strategy of university via green belt, green forested & blue plan of campus in accordance with the SI indicator. The university boasts a vast total open area spanning 889,134.9 m^2. Specifically, area of UNESA Ketintang covers 188,916.4167 m2, and area of UNESA Lidah Wetan extends over 700,218.5247 m^2. As a result, the proportion of open space to the entire area of the State University of Surabaya stands at an impressive 93.66%.

	Indicator	Point
SI.1	The ratio of open space area to total area	150
SI.2	Total area on campus covered in forest vegetation	100
SI.3	Total area on campus covered in plated vegetation	200
SI.4	Total area on campus for water absorption besides the forest and planted vegetation	100
SI.5	The total open space area divided by total campus population	100
SI.6	Percentage of university budget for sustainability efforts	200
SI.7	Percentage of operation and maintenance activities of building in one year period	75
SI.8	Campus facilities for disable special needs and/or maternity care	75
SI.9	Security and safety facilities	75
SI.10	Health infrastructure facilities for students, academics and administrative staffs' well-being	50
SI.11	Conservation: plant (flora) animal (fauna), or wildlife, genetic resources for food and agriculture secured in either medium or long-term conservation facilities	100

Fig. 2. Indicator and scores of settings and infrastructure.

Fig. 3. Green belt, green forested & blue plan of Lidah Wetan campus

4.2 Energy and Climate Change

The university has implemented energy-saving systems through the use of solar panels, smart lighting, and efficient air conditioning in several buildings [10]. However, electricity consumption remains quite high, especially in laboratory buildings. Interview results indicate that the academic community's low awareness of energy conservation remains a major obstacle. Strategies that can be strengthened include regular energy audits, student-based energy-saving campaigns, and the development of applied research related to renewable energy. The summaries of indicator and scores of energies and climate change is illustrated in Figure 4.

Indicator		Point
EC.1	Energy efficient appliances usage	200
EC.2	Smart building implementation	300
EC.3	Number of renewable energy sources on campus	150
EC.4	Total electricity usage divided by total campus' population	300
EC.5	The ratio of renewable energy production divided by total energy usage per year	150
EC.6	Elements of green building implementation as reflected in all construction and renovation policies	200
EC.7	Greenhouse gas emission reduction program	200
EC.8	Total carbon footprint divided by total campus' population	150
EC.9	Number of innovative program(s) ini energy and climate change	100
EC.10	Impactful university program(s) on climate change	100

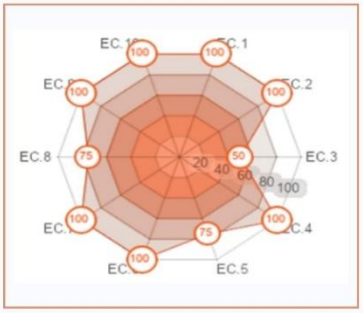

Fig. 4. Indicator and scores of energies and climate change.

Fig. 5. Solar panel installation and Biogas produced from Animal Waste at UNESA

An example of the use of solar panels is shown in Figure 5. Solar panels can lower costs for electricity by generating electricity from renewable sources. The university has currently installed some solar-powered outdoor lighting. This solar panel can generate 59,400 kWh of electricity in a year. It has also produced biogas as one of its alternative energy sources. The biogas generated by students is derived from animal waste. The biogas produced is subsequently converted into sustainable energy and used as an alternative fuel. The goal of employing this simple technique is to combat the decline of the environment. To prepare for climate change, biogas is highly suggested.

4.3 Waste Management

In waste management, the university has provided facilities for sorting organic, inorganic, and hazardous and toxic materials [11]. Furthermore, a student waste bank program is in place, although not yet widespread across all faculties. However, the level of discipline among facility users is still suboptimal. Observations indicate that most students still mix waste in public areas. Furthermore, the university needs to strengthen its zero-plastic policy,

recycling program, and provide incentives for students who actively participate in waste management. This is to support the waste management indicators and scores in Figure 6.

Indicator		Point
WS.1	3R (Reduce, Reuse, Recycle) program for university's waste	225
WS.2	Program to reduce the use of paper and plastic on campus	150
WS.3	Organic waste treatment	225
WS.4	Inorganic waste treatment	300
WS.5	Toxic waste treatment	300
WS.6	Sewage disposal	300

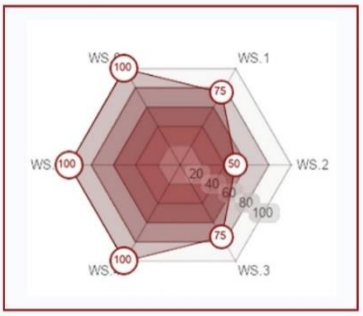

Fig. 6. Indicator and scores of waste management.

Fig. 7. Recycling of organic waste.

The strategy of Unesa has a waste recycling program that allows all types of materials, including plastic and organic waste. The process is carried out as shown in Figure 7 to create new products that increase the added value of waste. Success indicators include reducing waste by >50% and utilizing 75% of waste, such as processing it into compost and eco-enzymes to fertilize the ecosystem around Unesa. Unesa's waste recycling program includes:
Program to recycle organic waste into compost.

Unesa has initiated Organic Waste Composting for sustainable education and environmental preservation. Organic waste collected then placed in a composting structure that would help speed up the decomposition process. Compost is kept moist by adding constant water to facilitate the working of good microorganisms at the breakdown of wastes. Over a period of 2-3 months, the wastes get matured into nutrient-rich compost. This compost was then reused to enhance soil in campus gardens.
Program to recycle organic waste into eco-enzymes.

The organic waste, taken from peels of fruits and vegetables from the Unesa Canteen itself, is creatively reused for the production of eco-enzymes. This process begins with

sorting and processing by adding water and a natural sugar source, such as brown sugar or molasses, which acts as an essential nutrient for the bacteria and microbes that drive fermentation. Upon proper mixing, it is kept in an airtight container to ferment for three months. In this duration, the microbial activity takes place, wherein the organic material results in a potent, enzyme-rich solution, as eco-enzyme. After fermentation, this eco-enzyme serves as an all-purpose ecological cleaner, effectively taking out stains, disinfecting surfaces, and even serving as an air and water purifier. Besides, this solution is a very effective organic fertilizer that can ensure better growth and health for plants.

Program to recycle plastic waste into eco-brick.

Eco-brick products have already been used in the service program of Unesa students on the Eco Campus FMIPA Team. Ecobrick is a product created from plastic mineral water bottles filled with sorted plastic sachets that have been cleaned with soap. Following that, the plastic sachets are chopped into small pieces to aid in the drying process. The dried sachet pieces are then placed and crushed in a plastic drinking bottle until it is completely full.

4.4 Water

Water management on campus has implemented rainwater harvesting technology in several new buildings and the wastewater treatment plant (WWTP) [12]. However, budget constraints prevent this system from being fully implemented. Interviews revealed that technical staff acknowledged that there are still pipe leaks and wasteful water use, particularly in student dormitories. The academic community's role in water conservation is also not yet optimal. Strategies include expanding the use of automatic water-saving sensors, raising student awareness through the "Save Water" campaign, and developing innovative research related to campus-scale water treatment technology [12]. This is to support the water management indicators and scores in Figure 8. Furthermore, program implementation of water recycling to UNESA shows in Figure 9.

Indicator		Point
WR.1	Water conservation program & implementations	200
WR.2	Water recycling program implementation	150
WR.3	Water efficient appliances usage	100
WR.4	Consumption of treated water	150
WR.5	Water Pollution control in the campus area	150

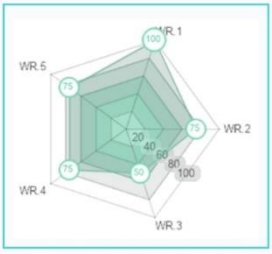

Fig. 8. Indicator and scores of waters.

Fig. 9. Water Recycling Program Implementation.

4.5 Transportation

The university's strategy is to reduce carbon emissions by implementing a policy restricting private motorized vehicles in the core campus area, expanding the shuttle bus fleet, and expanding bicycle lanes [13]. This is able to support the indicators and scores for the use of environmentally friendly transportation as shown in Figure 10. However, observations show that most students and lecturers still prefer to use private motorized vehicles. To address this, the university provides a dedicated parking area for motorized vehicles near the gate and tightens the policy of restricting motorized vehicles in the core campus area. The Parking Area is made with the Multi-Storey Motorbike as shown in Figure 11.

Indicator		Point
TR.1	The total number of vehicles (cars and motorcycles) divided by total campus' population	100
TR.2	Shuttle services	150
TR.3	Zero Emission Vehicles (ZEV) availability on campus	150
TR.4	The total number of Zero Emission Vehicles (ZEV) divided by total campus population	10
TR.5	Ratio of the ground parking area to the total campus area	150
TR.6	Program to limit or decrease the parking area on campus for the last 3 years	150
TR.7	Number of initiatives to decrease private vehicles on campus	150
TR.8	The pedestrian path on campus	225

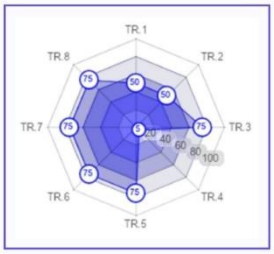

Fig. 10. Indicator and scores of transportations.

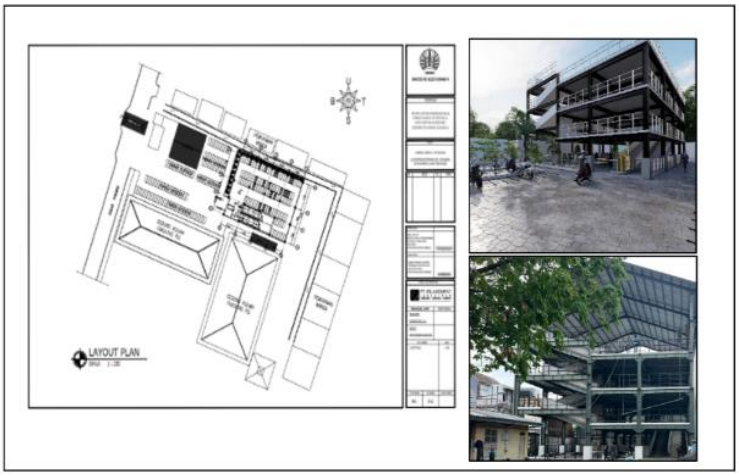

Fig. 11. Parking Area with the Multi Storey Motorbike

4.6 Education and Research

This indicator demonstrates quite good achievements. The university has incorporated sustainability issues into several interdisciplinary courses and encouraged research on renewable energy, conservation, and environmental innovation [14]. Students are also active in green communities, such as the plastic-free movement and environmental-based community service activities. However, a challenge is the lack of systematic integration of

sustainability throughout the curriculum [15]. Furthermore, the number of international publications related to sustainability remains limited. Therefore, universities need to develop a sustainability research roadmap, strengthen interdisciplinary collaboration, and integrate environmental values into all study programs as part of university strategies. This is to support for education and research from indicators and scores in Figure 12.

Indicator		Point
ED.1	The ratio of sustainability courses to total courses/subjects	300
ED.2	The ratio of sustainability research funding to total research funding	200
ED.3	Number of scholarly publications on sustainability	200
ED.4	Number of events related to sustainability (environment)	200
ED.5	Number of activities organized by student organizations related to sustainability per year	200
ED.6	University-run sustainability website	200
ED.7	Sustainability report	100
ED.8	Number of cultural activities on campus	50
ED.9	Number of university sustainability program (s) with international collaborations	100
ED.10	Number of community services related to sustainability organized by university and involving students	100
ED.11	Number of sustainability-related startups	100

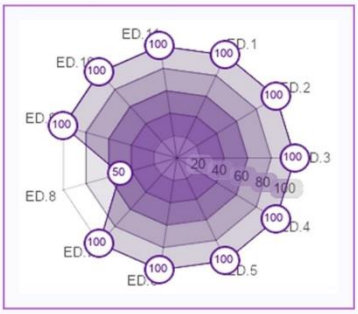

Fig. 12. Indicator and scores education and research.

In general, universities have initial strategies in place to strengthen the green university ecosystem, in accordance with the six UIGM indicators. However, implementation remains partial and faces challenges such as limited infrastructure, limited funding, and low academic participation. This demonstrates that the transformation towards a green university is not merely a matter of physical development; it also requires changes in culture, policy, and academic integration.

5 Conclusion

This study shows that strengthening the green university ecosystem based on UIGM's six indicators can support Greenmetric rankings and contribute significantly to the SDGs. The results confirm that the ecosystem strengthening strategy has been implemented through SI, EC, WS, WR, TR, and ER.

Based on the research findings, several strategic recommendations can be put forward: (1) SI by developing a master plan for green open spaces and optimal land use; (2) EC by implementing regular energy audits, expanding renewable energy utilization, and energy-saving awareness campaigns; (3) WS by implementing a zero-plastic policy, strengthening the waste sorting system, and developing incentive schemes for those actively involved in waste management; (4) WR by implementing automatic water-saving sensors and rainwater harvesting systems; (5) TR by expanding the shuttle bus fleet, expanding bicycle lanes, and

implementing a policy restricting private motorized vehicles in core campus areas to reduce carbon emissions; (6) ER by developing a cross-disciplinary sustainability-based curriculum, enhancing innovative environmental research, and developing a clear and ongoing sustainability research roadmap.

The main challenges facing universities are limited land and funding, low awareness among the academic community, a lack of supporting infrastructure, and the lack of integration of sustainability issues into the curriculum. This requires increased support and involvement of the entire academic community and students to ensure sustainability becomes part of the campus culture.

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