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Analysis and Waste Management Planning at Universitas Sulawesi Barat Based on the Green Campus Concept

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ABSTRACT

Background: The increasing number of students and academic activities at Universitas Sulawesi Barat (Unsulbar) has led to higher waste generation on campus. However, waste management at Unsulbar has not yet been supported by an integrated, systematic, and sustainable system aligned with Green Campus principles. **Objectives:** This study aimed to assess the existing condition of waste management at Unsulbar and to formulate strategic recommendations for improving campus waste management based on the Green Campus concept**. Methods:** A descriptive-exploratory design was employed using the Plan–Do–Check–Act (PDCA) framework. The study was conducted in five faculties over eight observation days. Data were collected through direct field observation, daily waste weighing, waste composition identification, interviews with cleaning staff, and assessment of waste management indicators based on UI GreenMetric criteria. **Results**: The findings showed that the average waste generation at Unsulbar was 0.229 kg/person/day, with plastic and paper/cardboard identified as the dominant waste components. The evaluation also revealed that campus waste management performance remains low, particularly in waste segregation, recycling programs, organic and inorganic waste treatment, and institutional policy support. **Conclusion**: Unsulbar needs to strengthen its waste management system through a 3R-based strategy, including faculty-based waste segregation, establishment of a campus waste bank, integrated composting, Zero Waste Campus campaigns, digital waste monitoring, and formal university-level waste management policies. These strategies are expected to support Unsulbar's transition toward a sustainable Green Campus and improve its future performance in the UI GreenMetric assessment. **Novelty/Originality**: This study provides an initial campus-based waste management assessment at Unsulbar using the PDCA framework and UI GreenMetric indicators, offering practical strategic recommendations for developing a sustainable Green Campus waste management model.

KEYWORDS: Green campus; PDCA; UI GreenMetric; Waste generation; Waste management.

1. INTRODUCTION

Higher education institutions play a strategic role in promoting sustainable development through the implementation of the green campus concept. This concept does not merely focus on aesthetic aspects, but also encompasses comprehensive environmental management, including effective and sustainable waste management (Too & Bajracharya, 2015). Data from the National Waste Management Information System indicate that Indonesia generates approximately 68.5 million tons of waste annually, with waste management performance remaining suboptimal (Ministry of Environment and Forestry, 2021). Higher education institutions contribute approximately 5–8% of total urban waste generation, with waste composition dominated by organic waste (40–50%), plastic (15–20%), and paper (10–15%) (Adeniran et al., 2017).

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The green campus concept promoted by the UI GreenMetric World University Rankings has become a global benchmark for assessing universities' commitment to environmental sustainability (Suwartha & Sari, 2013). One of the key indicators in this assessment is waste treatment and recycling, which accounts for 21% of the total score (Ragazzi & Ghidini, 2017). Recent studies have shown that conventional waste management practices in higher education institutions, such as open burning and limited waste segregation, contribute to air pollution and carbon emissions (Bahçelioğlu et al., 2020; Putra et al., 2021).

Universitas Sulawesi Barat (Unsulbar), with a student population of 14,323 (PDDIKTI, 2024), faces significant challenges in waste management. Preliminary observations indicate that Unsulbar does not yet have institutional policies or formal programs related to waste reduction. Waste segregation systems for organic, inorganic, and hazardous waste have not been implemented comprehensively across the campus. Open burning is still practiced, which can seriously affect air quality and is inconsistent with green campus principles and national regulations (Law No. 18 of 2008; Government Regulation No. 27 of 2020).

Case studies at several universities in Indonesia have found that the absence of formal policies and limited engagement of the academic community are major barriers to achieving the Waste indicator in the UI GreenMetric assessment (Pertiwi et al., 2025). Research on the characteristics and volume of campus waste is therefore a crucial initial step in designing an effective waste management system (Ziraba et al., 2016). The absence of comprehensive data on waste generation, composition, and characteristics at Unsulbar makes it difficult to design an appropriate waste management system.

Based on the above background, this study aims to: (1) analyze the generation, composition, and characteristics of waste at Universitas Sulawesi Barat; (2) identify the existing waste management system and its associated problems; (3) design an effective and sustainable waste management plan based on the green campus concept; and (4) formulate policy recommendations and implementation strategies for waste management at Universitas Sulawesi Barat.

2. MATERIALS AND METHODS

2.1 Research Design

This study employed a descriptive-exploratory research design using the Plan–Do–Check–Act (PDCA) framework. This approach was selected because it allows the study to describe the existing condition of campus waste management, identify management gaps, evaluate current practices, and formulate continuous improvement strategies. The PDCA cycle consisted of four main stages: planning, implementation, evaluation, and follow-up recommendation.

In the **Plan** stage, the research team identified the study sites, determined the waste observation points, prepared data collection instruments, and coordinated with faculty authorities and cleaning staff. In the **Do** stage, waste measurement, field observation, and interviews were conducted. In the **Check** stage, the collected

data were analyzed and compared with relevant Green Campus and UI GreenMetric waste management indicators. In the **Act** stage, strategic recommendations were formulated to improve the campus waste management system.

2.2 Study Site

The research was conducted at Universitas Sulawesi Barat, Majene, Indonesia. The study covered five faculties: the Faculty of Agriculture and Forestry, the Faculty of Health Sciences, the Faculty of Social, Political, and Legal Sciences, the Faculty of Economics, and the Faculty of Teacher Training and Education. These faculties were selected because they represent the main academic units of the university and generate waste from various academic, administrative, student, and operational activities.

The study was conducted during [insert month and year of data collection] over eight observation days. Coordination was carried out with the respective faculty authorities and cleaning staff to ensure that waste collection and weighing procedures could be implemented properly.

2.3 UI GreenMetric Waste Management Assessment

The existing waste management condition at Unsulbar was also evaluated using the waste management indicators of UI GreenMetric. The assessment focused on several aspects, including recycling programs, programs to reduce paper and plastic use, organic waste treatment, inorganic waste treatment, hazardous waste handling, and wastewater management. To improve clarity, the assessment table should include the following components: indicator code, indicator description, maximum score, obtained score, and remarks. This format allows readers to understand how the final score was determined and whether the score represents a raw score, converted score, or percentage of achievement.

2.4 Data Analysis

The data were analyzed descriptively using tables, percentages, averages, and comparative interpretation. Waste weight data were analyzed to determine the average daily waste generation in each faculty. Waste composition data were analyzed to identify the dominant types of waste. The results of field observations, interviews, and UI GreenMetric assessment were then integrated to identify the main gaps in campus waste management and to formulate strategic recommendations based on the 3R principles: Reduce, Reuse, and Recycle.

3. RESULTS AND DISCUSSION

3.1 Waste Weight and Waste Generation across Faculties

Waste weight measurements were conducted for eight observation days in five faculties at Universitas Sulawesi Barat, namely the Faculty of

Economics (FEKON), Faculty of Teacher Training and Education (FKIP), Faculty of Agriculture and Forestry (FAPERTAHUT), Faculty of Health Sciences (FIKES), and Faculty of Social, Political, and Legal Sciences (FISIPHUM). The daily waste weight varied among faculties and across observation days, indicating differences in academic, administrative, and operational activities within each faculty.

Based on the daily measurement data, the highest single-day waste weight was recorded in the Faculty of Economics, reaching 12.40 kg/day on the eighth observation day. However, when the data were analyzed based on the average daily waste weight, the Faculty of Health Sciences recorded the highest average, with 7.999 kg/day. This distinction is important because the maximum daily value represents a peak observation, whereas the average value reflects the overall waste generation tendency during the observation period.

Table 1. Waste Weight by Faculty

Day	FEKON	FKIP	FAPERTAHUT	FISIPHUM	FIKES
1	5.80	4.43	8.34	4.38	10.57
2	4.65	5.17	2.94	2.81	7.27
3	2.32	3.04	3.93	4.92	6.52
4	10.735	4.04	4.90	5.20	6.21
5	3.97	4.42	6.83	6.61	8.65
6	8.003	5.55	4.85	1.67	8.80
7	8.09	6.28	5.48	4.00	7.80
8	12.40	8.73	5.95	2.23	8.17
Average (kg/day)	**6.996**	**5.208**	**5.403**	**3.978**	**7.999**

Source: Primary Data Calculation, 2025

The average waste weight across all faculty observations was 5.916 kg/faculty/day. Among the five faculties, FIKES generated the highest average daily waste weight, followed by FEKON, FAPERTAHUT, FKIP, and FISIPHUM. The higher average waste weight in FIKES may be associated with more intensive academic and practical activities, higher use of disposable materials, and the presence of health-related learning activities. Meanwhile, the relatively high fluctuation in FEKON suggests that waste production in this faculty may be influenced by specific events, student activities, or variations in daily campus attendance.

The total daily waste generated by all five faculties also fluctuated during the observation period. The highest total waste generation occurred on the eighth day, while the lowest occurred on the third day. This pattern indicates that campus waste generation is dynamic and may be influenced by the academic calendar, teaching schedules, student presence, administrative activities, and the use of campus facilities.

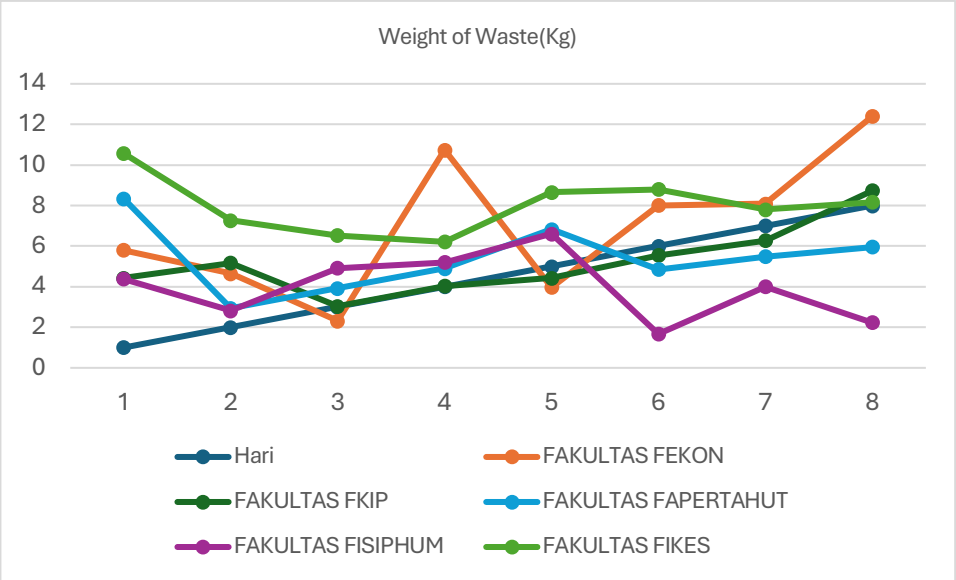

Figure 1. Graph of Waste Weight in Each Faculty

In addition to measuring waste weight in kilograms, this study calculated waste generation in kg/person/day. The average waste generation across the five faculties was 0.229 kg/person/day. This value is still within the general range of campus waste generation reported in Indonesia, but it remains important to improve waste management because the composition was dominated by recyclable materials, particularly plastic and paper/cardboard.

Table 2. Waste Generation over Eight Days by Faculty

Day	FEKON	FKIP	FAPERTAHUT	FIKES	FISIPHUM
First	0.038	0.294	0.162	0.189	0.227
Second	0.047	0.252	0.459	0.275	0.354
Third	0.094	0.428	0.344	0.307	0.202
Fourth	0.020	0.322	0.276	0.322	0.191
Fifth	0.055	0.294	0.198	0.231	0.150
Sixth	0.027	0.235	0.278	0.227	0.597
Seventh	0.027	0.207	0.247	0.256	0.249
Eighth	0.018	0.149	0.227	0.245	0.445
Average	**0.041**	**0.273**	**0.274**	**0.257**	**0.302**

Source: Primary Data Calculation, 2025

The highest average waste generation per person was found in FISIPHUM, with 0.302 kg/person/day, followed by FAPERTAHUT, FKIP, FIKES, and FEKON. This finding differs from the waste weight data, in which FIKES recorded the highest average waste weight. The difference between total waste weight and waste generation per person indicates that the number of students, lecturers, and staff in each faculty strongly affects the kg/person/day calculation. Therefore, future analysis should clearly present the population data of each faculty to allow transparent verification of the waste generation rate.

The relatively low waste generation value in FEKON does not necessarily indicate better waste management performance, because it may be influenced by the larger number of people used as the denominator in the calculation. Thus, interpretation of kg/person/day data should consider both total waste weight and faculty population size.

3.2 Waste Composition at Universitas Sulawesi Barat

Waste composition analysis was conducted by classifying waste into three main categories: plastic, paper/cardboard, and other types of waste. The analysis showed that plastic and paper/cardboard were the dominant waste components in all faculties. This finding indicates that a large proportion of campus waste has the potential to be reduced, reused, or recycled if a proper source-based waste segregation system is implemented.

The percentage values in the waste composition table were recalculated based on the weight of each waste category relative to the total waste composition in each faculty. The revised percentage values are presented in Table 3.

Table 3. Waste Composition at Universitas Sulawesi Barat

Waste Type	FKIP		FEKON		FAPERTAHUT		FIKES		FISIPHUM	
	Kg	%	Kg	%	Kg	%	Kg	%	Kg	%
Plastic	1.52	38.48	3.08	53.57	1.93	46.51	3.72	55.11	1.02	35.42
Paper/ Cardboard	2.28	57.72	2.67	46.43	2.22	53.49	3.03	44.89	1.86	64.58
Other types	0.15	3.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: Primary Data Calculation, 2025

The revised composition data indicate that paper/cardboard was dominant in FKIP, FAPERTAHUT, and FISIPHUM, whereas plastic was dominant in FEKON and FIKES. In FKIP, paper/cardboard accounted for 57.72% of the total analyzed waste composition, while plastic accounted for 38.48%. In FEKON, plastic contributed 53.57%, making it the dominant waste type in this faculty. FAPERTAHUT showed a relatively balanced composition, with paper/cardboard at 53.49% and plastic at 46.51%. In FIKES, plastic was the largest component, accounting for 55.11%. Meanwhile, FISIPHUM had the highest proportion of paper/cardboard waste, reaching 64.58%.

Overall, plastic and paper/cardboard represented the dominant waste types across the observed faculties. This finding suggests that waste management strategies at Unsulbar should prioritize paper reduction, plastic reduction, and recyclable waste recovery. The high proportion of paper/cardboard may be related to academic and administrative activities, such as printing, assignment submission, office documentation, and packaging materials. Meanwhile, plastic waste may originate from food and beverage packaging, single-use containers, plastic bags, and student activities.

These findings support the need for a faculty-based waste segregation system. Faculties with a higher proportion of paper/cardboard waste should prioritize paper reduction programs, digital document systems, and paper recycling. Faculties with higher plastic waste composition, such as FEKON and

FIKES, should prioritize single-use plastic reduction policies, reusable bottle campaigns, and collaboration with local recycling collectors. Therefore, waste management planning should not be uniform across all faculties, but should be adjusted to the specific waste characteristics of each faculty.

3.3 Check Stage

The measurement results showed that waste generated in the five faculties at Unsulbar was dominated by paper and plastic, which accounted for more than 80% of the total waste volume. Waste generation across faculties ranged from 5 to 8 kilograms per day, indicating the need for a more optimal waste segregation system at the source. When compared with the national average standard for campuses in Indonesia, which is approximately 0.2–0.4 kg/person/day according to SNI 19-3964-1994, the waste generation measured at Unsulbar remains within the normal range. However, the dominant proportion of plastic and paper waste (>80%) indicates the need to implement source-based waste segregation so that these materials can be reused or recycled through the 3R program: Reduce, Reuse, and Recycle.

In terms of facilities, each building already has waste bins; however, waste segregation based on waste type, namely organic, inorganic, and hazardous waste, has not been implemented consistently. Most waste is still collected without prior segregation and is burned in open areas, which may contribute to air pollution. From a behavioral perspective, the academic community demonstrates a fairly good awareness of the importance of waste management, although the level of participation remains low. The evaluation of the existing waste management condition based on the UI GreenMetric Waste category (Waste/WS) produced the scores presented in Table 4 below.

Table 4. Proposed Format for UI GreenMetric Waste Management Assessment

Code	Category and Indicator	Description	Score
WS.1	Waste recycling program on campus	Waste bins are already available in each faculty; however, waste is still mixed with other types of waste. There is no waste segregation system implemented in each faculty. A recycling program at Unsulbar is not yet available.	0
WS.2	Campus program to reduce paper and plastic use	The use of paper has been reduced during midterm and final examinations through the use of several applications, including Quizizz. Assignment submission is also conducted through Google Drive and Google Classroom. In addition, during the new student orientation program (PKKMB) and other student activities, students are required to use tumblers. However, there is still no formal policy regulating the reduction of plastic waste.	0.50 × 300 = 150
WS.3	Organic waste treatment	In general, organic waste treatment has not yet been implemented. However, organic waste such as food scraps from the canteen is collected and given to livestock by the canteen owners.	0.25 × 300 = 75
WS.4	Inorganic	Inorganic waste, such as plastic and paper/cardboard,	0.25 ×

	waste treatment	generally dominates waste generation in each faculty. There is no permanent segregation and treatment system; this waste is collected and sold to local waste collectors.	300 = 75
WS.5	Toxic waste handling	Hazardous and toxic waste has not yet been handled separately from other types of waste. This indicator is not yet implemented.	0
WS.6	Sewage disposal	Unsulbar has dedicated wastewater treatment facilities (WWTPs), located in the Integrated Laboratory Building and Building B of the Faculty of Medicine.	0.50 × 300 = 150
		Total	**450**
		Achievement Score	**25**

The assessment results based on the UI GreenMetric indicators presented in Table 4 above show that the waste management category obtained a score of 25 out of a total of 450 points. This indicates that the campus waste management system still needs to be significantly improved. The evaluation also highlights that waste segregation and recycling programs have not yet been implemented due to the absence of a strong institutional structure and monitoring system. Based on these evaluation results, the Check stage revealed several gaps between planning and implementation, namely:

1. The waste segregation system has not been fully implemented in each faculty.
2. There is no official policy or standard operating procedure (SOP) related to 3R-based waste management.
3. Supporting facilities, such as a waste bank, composting units, and a standard temporary waste storage facility (TPS), are not yet available.
4. Educational programs, such as socialization activities for the academic community, are still limited.
5. There is no periodic monitoring and evaluation system to assess the effectiveness of waste management.

3.4 Act Stage

Program Recommendations

Based on the analysis, most of the waste generated within Universitas Sulawesi Barat (Unsulbar) comes from the daily activities of students and administrative staff, with the largest proportion consisting of inorganic waste, such as plastic and paper/cardboard. Considering this condition and the low UI GreenMetric assessment results, several strategic programs need to be implemented at the faculty level to improve the effectiveness of waste management.

1. Faculty-Based Waste Segregation Program
   This program involves providing separate waste bins for organic, inorganic, and hazardous and toxic waste (B3) in every building and student activity area. It should be supported by regular monitoring and evaluation by the faculty cleaning team so that the habit of segregating waste can be developed directly at the source.

2. Campus Waste Bank Program
   This program can be managed by students through an environmental student organization or Student Activity Unit (UKM). It can be implemented with support from the university and in collaboration with the Environmental Agency (DLH) of Majene Regency or local waste collectors. The waste bank functions as a collection and processing center for recyclable inorganic waste with economic value, thereby reducing the amount of waste disposed of while also providing economic benefits for its managers.
3. Integrated Composting Program
   This program aims to process organic waste into compost. The resulting compost can be used for campus greening activities or distributed to the surrounding community as part of Unsulbar's contribution to community service.
4. "Zero Waste Campus" Education and Campaign Program
   This program includes training activities, inter-faculty cleanliness competitions, environmental seminars, and awareness campaigns on the use of reusable items. The program aims to increase awareness among the academic community about reducing single-use plastics by bringing personal tumblers, lunch boxes, and reusable shopping bags.
5. Digital Waste Monitoring System
   This system can be developed using a web-based platform or Google Forms to record and monitor the amount and types of waste generated in each faculty. The data collected through this system can be used for periodic evaluation and as a basis for continuous improvement in the next PDCA cycle.

Policy Recommendations

Based on the research findings, Universitas Sulawesi Barat (Unsulbar) needs to strengthen its internal policy framework so that the waste management system can be implemented consistently and sustainably. Therefore, the following policy recommendations are proposed:

a. Formulation of a Rector's Regulation on Green Campus-Based Waste Management
   This regulation should contain guidelines and standard operating procedures (SOPs) for waste segregation, collection, processing, and final disposal across all campus units. The regulation would serve as an official reference for each faculty and work unit in implementing waste management in a uniform and measurable manner.

b. Implementation of a Policy to Reduce Single-Use Plastics
   This policy can be introduced through an official circular prohibiting the use of bottled drinking water in plastic packaging during campus activities and replacing it with gallon water dispensers in each faculty. The policy can also be strengthened by encouraging students and staff to bring reusable eating and drinking utensils.

c. Establishment of a Campus Waste Management Unit (UPS)
This unit should operate under the coordination of the Vice Rector for Student Affairs and Cooperation. It would be responsible for designing, implementing, and evaluating all waste management activities within the campus environment. The unit is also expected to collaborate with the Environmental Agency (DLH) of Majene Regency, private institutions, and environmental communities to strengthen program effectiveness and sustainability.

d. Establishment of Environmental Awards and Incentives
Awards and incentives should be provided to faculties, work units, and student organizations that are active and innovative in waste management activities. This effort is expected to encourage positive competition in maintaining campus cleanliness.

e. Allocation of a Specific Budget for Environmental Programs
A dedicated budget for environmental programs should be included in the university's Strategic Plan (Renstra) and Annual Work Plan and Budget (RKAT). With consistent budgetary support, waste management activities at Unsulbar can be implemented sustainably and become an integral part of the university's commitment to becoming an environmentally friendly and competitive Green Campus.

4. CONCLUSION

The research findings indicate that the waste management system at Universitas Sulawesi Barat (Unsulbar) remains suboptimal and has not yet fully aligned with Green Campus principles. Waste generation within the campus environment is relatively high, with an average of 0.229 kg/person/day, and is dominated by inorganic waste, particularly plastic and paper, which account for more than 80% of the total waste volume. This condition reflects the low effectiveness of institutional policies, waste segregation systems, and the participation of the academic community in waste management. The evaluation using UI GreenMetric indicators shows that Unsulbar obtained only 25 out of a total of 450 points in the waste management category. This indicates the weakness of recycling programs, organic and inorganic waste treatment, and the absence of hazardous and toxic waste (B3) management systems as well as source-based waste segregation. Although the academic community demonstrates a fairly good awareness of the importance of waste management, the actual implementation of waste management practices remains limited. To achieve a sustainable green campus, this study recommends the implementation of a waste management program based on the 3R principles: Reduce, Reuse, and Recycle. This can be carried out through several strategic measures, namely: 1) Faculty-based waste segregation using separate waste bins. 2) Establishment of a Campus Waste Bank managed by students. 3) Development of an integrated composting program for organic waste. 4) Implementation of education programs and Zero Waste Campus campaigns. 5) Use of a digital system for monitoring and evaluating waste generation.

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