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Assessing Campus Waste Management for Sustainability: A Case Study of Hasanuddin University, Indonesia (Unhas)

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Abstract This study examines the current waste management system at Hasanuddin University (Unhas), Indonesia, as the institution transitions from a conventional collect–dispose approach toward a more integrated and sustainability-oriented model. Using a qualitative case study design, data were collected through semi-structured interviews, document analysis, and field observations, and were analyzed thematically following Braun and Clarke's framework. The findings identify four interrelated challenges that constrain system performance: fragmented institutional coordination, weak source-segregation behavior among waste generators, limited technical capacity for composting and material recovery, and the absence of an embedded environmental culture across campus units. Despite these constraints, the study reveals tangible opportunities for circular improvement, including scaling up composting operations, strengthening waste bank integration, enhancing environmental literacy initiatives, and leveraging behavioral interventions such as bin-removal policies to improve waste discipline and campus cleanliness. The key contribution of this study lies in the development of a multidimensional waste governance model specifically tailored to Indonesian public higher education institutions. The proposed framework integrates regulatory, institutional, financial, empowerment, and technical dimensions as a coherent strategy for implementing Integrated Solid Waste Management at the university level. By advancing a governance-oriented and context-specific approach, this study provides practical and theoretical insights to support circular campus transitions. It strengthens the role of higher education institutions in achieving Sustainable Development Goal 11 and Sustainable Development Goal 12, particularly within the Global South.

Keywords Campus Waste Management, Campus Governance, Waste Policy, Integrated Solid Waste Management (ISWM), Circular Economy, Higher Education Institutions

1. Introduction

The management of solid waste has become a significant global issue, particularly in urban and institutional settings characterized by high population density and intensive human activity [1-3]. Higher education institutions (HEIs), as integral components of urban systems, produce diverse waste streams resulting from academic, administrative, and commercial activities [4,5]. As "living laboratories", universities are increasingly expected to exhibit leadership in incorporating sustainability principles into their operational practices, governance structures, and community engagement [6,7]. Consequently, waste management has become a central component of campus

sustainability agendas, with direct implications for environmental performance, institutional culture, and policy alignment.

Empirical research demonstrates that numerous universities, particularly those situated in the Global South, face ongoing challenges in transitioning from traditional collect–dispose systems to Integrated Solid Waste Management (ISWM) frameworks, which emphasize waste reduction, reuse, recycling, and circular economy principles [8]. Despite the increasing availability of physical infrastructure such as segregated bins, composting units, and recycling facilities, the effectiveness of these systems remains heavily reliant on institutional coordination, leadership commitment, financial mechanisms, behavioral engagement, and regulatory clarity [9,10]. These challenges indicate that technical interventions alone are inadequate for achieving sustainable waste management outcomes in higher education settings.

In Indonesia, although Law No. 18/2008 on Waste Management has been enacted and national policies advocate for the 3R approach, implementation at the campus level remains inconsistent. Existing research predominantly focuses on technical aspects such as waste composition analysis, generation rates, or isolated awareness programs, while giving limited attention to institutional governance, policy integration, and cross-unit coordination [11]. Consequently, the broader socio-institutional mechanisms influencing campus waste management performance remain underexplored.

Hasanuddin University (Unhas), a prominent public institution in Eastern Indonesia, operates within a multifaceted institutional framework that produces significant quantities of both organic and inorganic waste on a daily basis. Preliminary evaluations utilizing gravimetric waste characterization reveal that organic waste constitutes the predominant component, with plastic and paper identified as the primary recyclable materials [12]. Despite the existence of waste banks, composting facilities, and source-segregated bins, waste segregation practices remain inconsistent, institutional responsibilities are fragmented, and enforcement mechanisms are inadequate. Notably, waste sorting is predominantly conducted by cleaning staff rather than the waste generators themselves, a structural impediment widely acknowledged in the literature as detrimental to effective source separation and the implementation of Integrated Solid Waste Management (ISWM) [13].

International experiences from institutions such as Mahidol University, the University of Tokyo, UC Berkeley, and Wageningen University illustrate that effective campus waste management systems are supported by robust policy frameworks, institutional coordination, sustained financial resources, and active stakeholder engagement [14,15]. These cases serve as contextual benchmarks rather than direct models, emphasizing the significance of governance-driven approaches that are adaptable to local institutional and socio-economic conditions.

Collectively, the literature identifies a distinct research gap. Investigations into campus waste management in Indonesia are predominantly fragmented and technical in nature, with insufficient empirical focus on governance structures, institutional coordination, and comprehensive sustainability strategies [8,11,14]. Furthermore, there is a significant absence of empirical models that systematically incorporate regulatory, institutional, financial, empowerment, and technological dimensions within the specific context of Indonesian public universities [6,16,17].

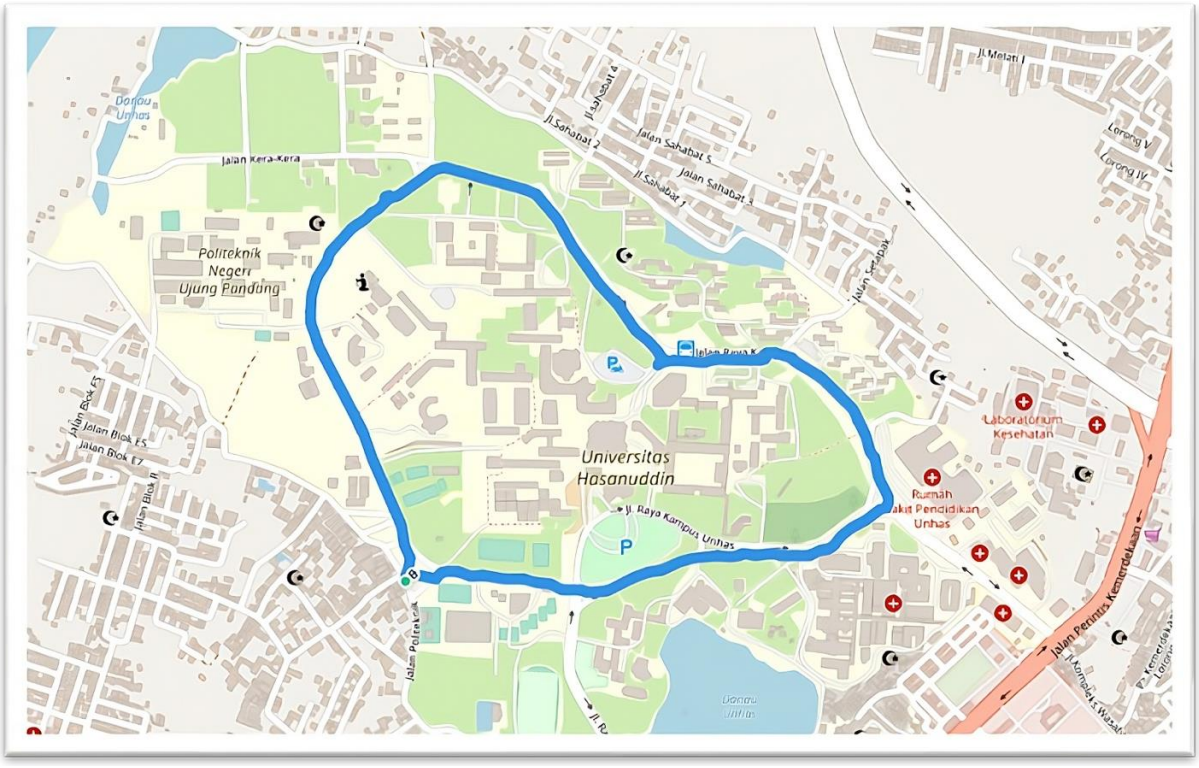
In addressing this gap, the present study investigates the waste management system at Hasanuddin University and proposes a five-dimensional waste governance model. This model encompasses regulatory, institutional, financial, empowerment, and technical–technological dimensions, representing the principal innovation of the study. It offers a governance-oriented and context-specific framework for implementing Integrated Solid Waste Management in Indonesian higher education institutions. By aligning campus waste governance with circular economy principles and the Sustainable Development Goals, particularly SDG 11 and SDG 12, this study provides both theoretical and practical contributions to sustainability transitions in higher education institutions within the Global South.

2. Material and Methods

2.1. Research Design and Study Area

The present study utilized an interpretive qualitative case study design to investigate the socio-institutional dynamics influencing campus waste management at Hasanuddin University. An interpretive approach is deemed suitable for examining how actors and institutions construct meaning around waste-related practices, policies, and organizational processes [18]. The qualitative case study method was chosen due to the complexity of campus waste systems, which encompass interrelated governance structures, operational units, behavioral patterns, and infrastructural conditions necessitating a holistic and context-sensitive analysis [19].

The research was conducted at the Tamalanrea Campus of Hasanuddin University, located in Makassar, Indonesia (Figure 1). This campus was selected due to its large academic population, high intensity of academic and commercial activities, significant daily waste generation, and the presence of existing waste management initiatives, including a campus waste bank and composting facilities. These characteristics make Unhas an appropriate case for examining sustainability-oriented waste management practices within a public higher education institution in a developing country context.



Source: Authors' mapping based on administrative boundary data from the Indonesian Geospatial Information Agency (BIG) and satellite imagery from Google Earth

Figure 1. Map showing the location of the Hasanuddin University (Unhas) Tamalanrea Campus, Makassar, South Sulawesi, Indonesia

2.2. Data Collection and Participants

Data collection was executed through a triangulated qualitative methodology, incorporating semi-structured interviews, document analysis, and systematic field observations, in alignment with established best practices in qualitative environmental governance research [20]. Semi-structured interviews were conducted with 15 participants, who were purposively selected to encompass a range of institutional perspectives. The participant cohort included 4 university-level administrators and policy actors, 5 operational staff members engaged in waste management and cleaning services, 3 faculty members, and 3 students. This composition ensured the representation of policy, operational, and user-level perspectives, while maintaining ethical standards of anonymity and voluntary participation [21].

Purposive and maximum variation sampling techniques were employed to ensure participants had direct experience and contextual knowledge pertinent to campus waste management processes [21]. The interviews concentrated on institutional roles, policy implementation, operational challenges, behavioral practices, and perceptions of sustainability initiatives. Document analysis encompassed university regulations, internal operational guidelines issued by the Directorate of Facilities Management and Maintenance (DFMM), national waste management legislation, institutional sustainability reports, and waste composition data [12]. Field observations were conducted across various campus locations, including canteens, classrooms, public spaces, composting facilities, and the waste bank, to document real-time waste segregation behavior, infrastructure conditions, and operational practices.

2.3. Data Recording, Transcription, and Analytical Implications

Owing to institutional and ethical constraints concerning data confidentiality and participant consent, verbatim audio recordings and complete interview transcripts were not generated. Instead, detailed interview notes were taken contemporaneously and expanded immediately following each interview. Although the absence of verbatim transcripts may constrain fine-grained discourse analysis, this limitation was addressed through several strategies. Firstly, interview data were triangulated with document analysis and systematic field observations to enhance analytical depth and credibility [20]. Secondly, thematic patterns were cross-validated against established findings in the sustainability and higher education literature to ensure analytical plausibility [6,16]. Thirdly, the analysis concentrated on pattern-level interpretation and governance dynamics, which are well suited to synthesizing qualitative data rather than micro-linguistic analysis [19].

2.4. Data Analysis

The qualitative data were analyzed through Thematic Analysis, adhering to the six-step framework established by Braun and Clarke [22]: data familiarization, initial coding, theme generation, theme refinement, theme definition, and narrative synthesis. The coding process was conducted inductively, allowing themes to emerge organically from the data rather than being predetermined. The resulting codes were organized into higher-order thematic categories that correspond to regulatory, institutional, behavioral, financial, and technological dimensions, aligning with the Integrated Solid Waste Management (ISWM) and campus sustainability frameworks [23,24].

Themes were iteratively reviewed and refined to ensure both internal coherence and external validity. Analytical interpretations were continuously compared with relevant theories of environmental governance, ISWM, and sustainability transitions in higher education institutions to enhance conceptual alignment.

2.5. Trustworthiness and Ethical Considerations

To ensure methodological rigor, the study adhered to Lincoln and Guba's criteria of trustworthiness [25]. Credibility was enhanced through methodological triangulation across interviews, documents, and observations, as well as through consistency checks with established literature. Transferability was supported by providing detailed contextual descriptions of the institutional setting and waste management system. Dependability was ensured through the systematic application of interview protocols and the maintenance of an audit trail documenting analytical decisions. Confirmability was reinforced through reflexive practices, including explicit acknowledgment of methodological limitations and the grounding of interpretations in empirical evidence rather than researcher assumptions.

Ethical considerations were rigorously observed throughout the study. Participants were informed of the research objectives, anonymity and confidentiality were guaranteed, institutional permission was obtained, and sensitive operational information was anonymized in accordance with ethical standards for qualitative institutional research [26].

2.6. Methodological Limitations

While this study is methodologically rigorous, it is not without limitations. The lack of verbatim interview transcripts restricted the depth of linguistic analysis. Furthermore, the cross-sectional design impedes the ability to observe longitudinal changes in behavior or institutional practices. Nonetheless, the triangulated qualitative approach and systematic analytical framework offer sufficient robustness to substantiate the study's conclusions and its proposed governance model.

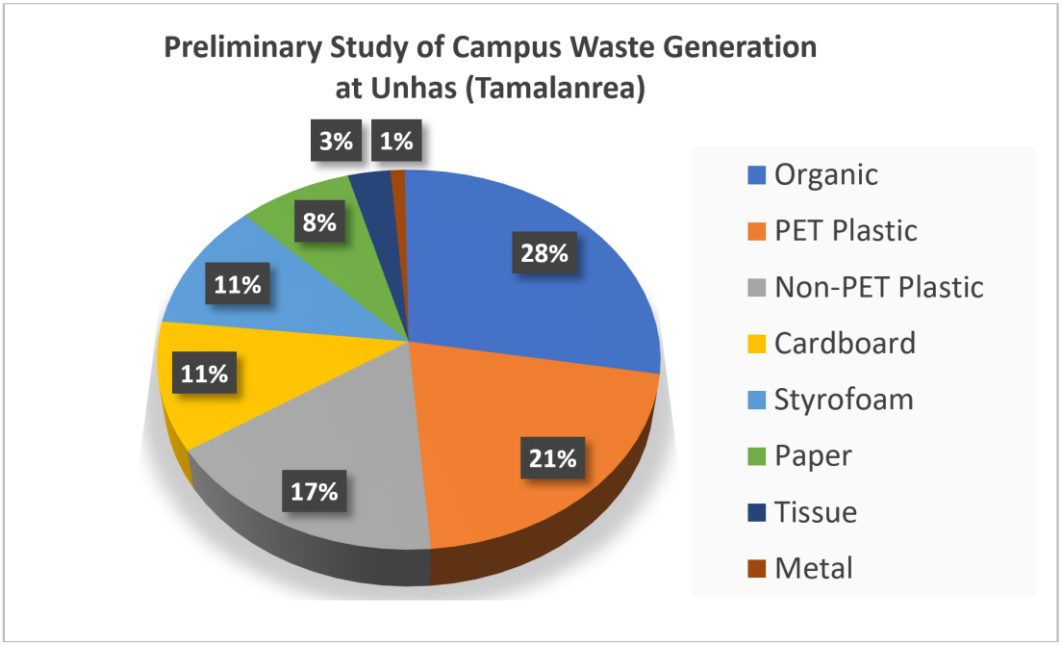
3. Results and Discussion

This section presents the research findings and their discussion in an integrated manner to offer a comprehensive understanding of the dynamics of waste management at Hasanuddin University. The findings were derived through the triangulation of interviews, field observations, and the analysis of pertinent institutional documents. Subsequently, all data were analyzed using a thematic approach based on Braun and Clarke's [22] framework, which facilitated the identification of key patterns in waste management practices and the factors that influenced their effectiveness.

3.1. Existing Waste Management Conditions at Unhas

Waste management at Hasanuddin University (Unhas) is influenced by the spatial dimensions of the Tamalanrea campus, the high mobility of its academic community, and the intensity of academic, administrative, and commercial activities. According to the waste characterization report issued by the Department of Environmental Engineering, Faculty of Engineering, Hasanuddin University [12], the average waste generation rate is approximately 0.12 kg per person per day, which is lower than the national average of 0.4 kg per person per day reported by the Ministry of Environment and Forestry [27]. Although the per capita generation rate is relatively modest, the diversity and composition of waste streams present substantial challenges for effective sorting and downstream processing.

Gravimetric analysis reveals that organic waste comprises the largest proportion of total waste generation at 28%, followed by PET plastic at 21%, non-PET plastic at 17%, cardboard at 11%, styrofoam at 11%, paper at 8%, tissue at 3%, and metal at 1% [12]. As depicted in Figure 2, the predominance of organic waste indicates significant potential for composting-based management strategies, aligning with findings from previous studies on waste management in educational institutions [1]. Conversely, the substantial proportion of plastic waste, particularly single-use plastics, reflects consumption patterns typically observed in high-activity urban and institutional settings [2]. The presence of styrofoam is particularly concerning due to its resistance to degradation and its association with microplastic pollution [28].



Source: Department of Environmental Engineering, Faculty of Engineering, Hasanuddin University, 2018

Figure 2. Composition of Waste Generation at Hasanuddin University

From an institutional standpoint, Unhas has officially implemented a waste classification system that includes organic, garden, inorganic, and residual waste, as governed by internal policies under the oversight of the Directorate of Facilities Management and Maintenance (DFMM). Nevertheless, field observations indicate that the system's effectiveness is limited. Waste sorting at the source is inconsistently executed across campus units, with the responsibility for segregation predominantly transferred to cleaning personnel during collection, rather than being undertaken by waste generators at the point of disposal. This situation has been extensively recognized in the literature as a structural impediment to effective source separation and the successful implementation of Integrated Solid Waste Management (ISWM) systems in university environments [13].

Operationally, waste collected from campus units is temporarily stored at the TPS3R facility before being directed to specific treatment pathways, including composting units, the campus waste bank, or final disposal at the Tamangapa Landfill. The overall waste flow is depicted in Figure 3, which illustrates the functional linkages among waste generation, collection, processing, and disposal within the campus system. Organic waste is allocated to composting facilities, recyclable materials such as plastic and paper are transferred through the campus waste bank to the Makassar City Waste Bank, and residual waste is transported to the final disposal site. This flow structure indicates that Unhas has adopted the fundamental principles of ISWM, including source segregation, prioritization of material recovery, and minimization of landfill disposal. Nevertheless, the system remains constrained by inconsistent source separation, limited composting capacity, and the absence of mechanical sorting technologies, such as Material Recovery Facilities (MRFs). Similar limitations have been reported across university campuses and urban areas in developing countries, where infrastructural and governance constraints hinder the full operationalization of ISWM frameworks [8].

Overall, the current waste management conditions at Unhas signify a transitional phase towards a more integrated and sustainability-oriented system. The presence of composting facilities, waste banks, and selective bins establishes a structural foundation for circular waste management. Furthermore, the implementation of behavioral interventions, such as the removal of waste bins from selected public areas, has been associated with reduced illegal dumping and improved campus cleanliness, indicating the potential effectiveness of nudging approaches in influencing disposal behavior [17]. However, the long-term sustainability of these initiatives remains contingent upon strengthened institutional coordination, enhanced environmental literacy among campus users, and the availability of adequate processing infrastructure to support consistent source separation. These conditions underscore the necessity for governance-oriented interventions that extend beyond technical measures, which are examined further in the subsequent thematic analysis.

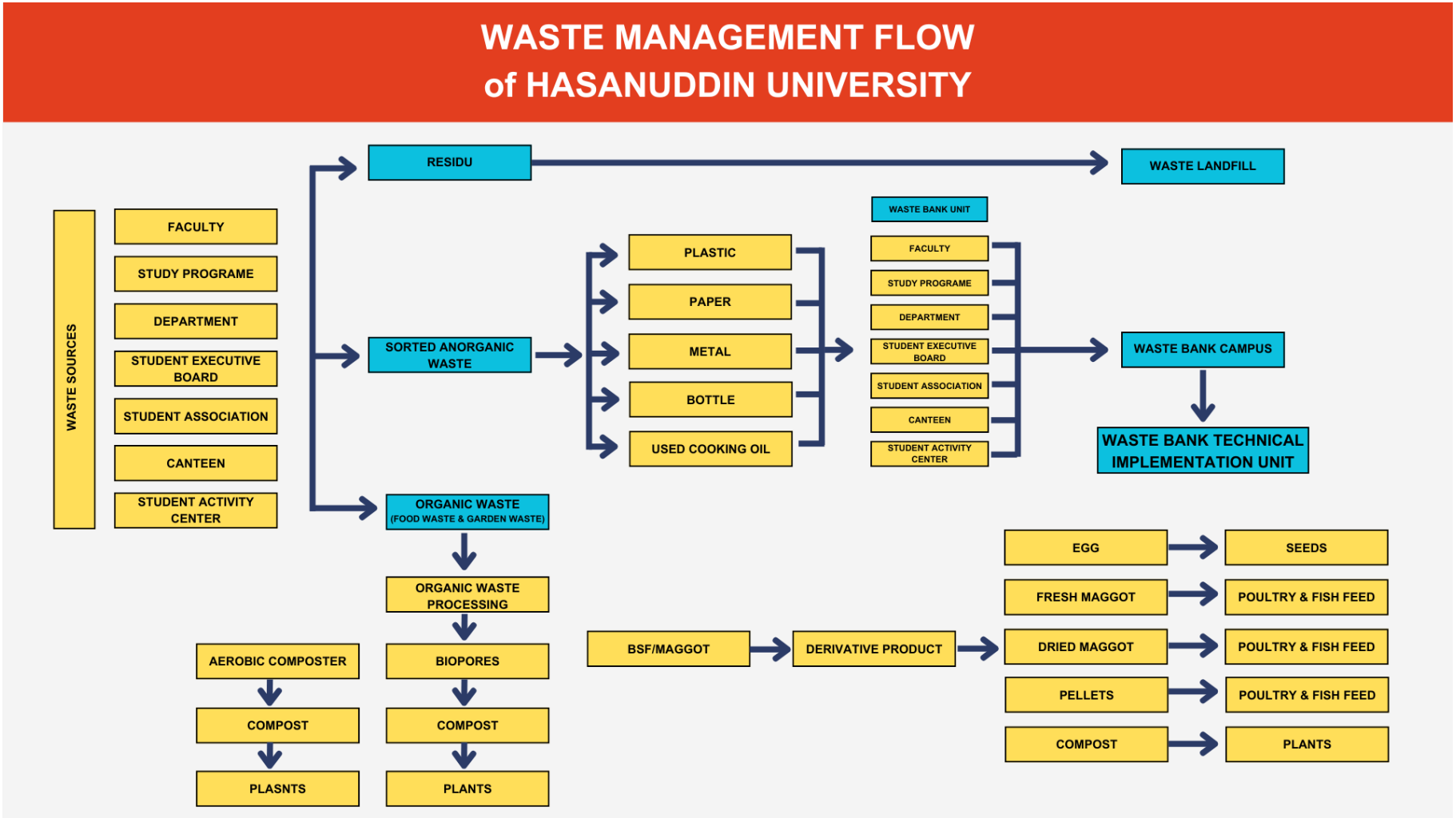


Figure 3. Waste Management Flow at Unhas Campus

3.2. Thematic Findings

The thematic analysis of interview data, field observations, and institutional documents identified four interrelated themes that collectively characterize the current waste management system at Hasanuddin University. These themes were developed through an inductive coding process following Braun and Clarke's six-stage framework [22]. During the initial familiarization and open coding stages, recurring codes emerged related to institutional roles, waste-handling practices, infrastructural constraints, and sustainability values. These codes were subsequently grouped through axial coding into higher-order conceptual categories and iteratively refined to ensure analytical coherence and distinction. This process resulted in four overarching themes: fragmented institutional coordination, behavioral practices related to source segregation, limited technical capacity, and weakly embedded environmental culture, which reflect core dimensions influencing the effectiveness of campus waste management systems [23,24].

Empirical evidence suggests that waste governance at Hasanuddin University is characterized by fragmented institutional coordination. While the Directorate of Facilities Management and Maintenance (DFMM) assumes a central operational role, its coordination with faculties, laboratories, and other academic units remains limited. Interviewees consistently emphasized the lack of clear divisions of responsibility and the absence of cross-unit Standard Operating Procedures (SOPs). One administrative respondent observed that "waste management is formally under DFMM, but in practice each faculty handles waste in its own way." This fragmentation has led to inconsistent implementation of sorting policies across campus units, despite the existence of formal regulations. Similar patterns of institutional incoherence have been extensively documented in higher education institutions in developing countries. They are recognized as a significant constraint on effective Integrated Solid Waste Management (ISWM) implementation [29].

Behavioral practices concerning waste segregation represent a significant theme. Field observations consistently revealed that waste sorting is primarily executed by cleaning staff during collection, rather than by waste generators at the point of disposal. This pattern was evident across classrooms, laboratories, and public spaces, including areas equipped with segregated bins. A member of the cleaning staff explained, "most waste comes mixed, so we separate it later when collecting." These observations indicate that source segregation has not yet been internalized as a routine behavioral norm among students and staff. Rather than reflecting a lack of awareness, the findings suggest a structurally reinforced dependence on janitorial labor and the absence of institutional incentives and enforcement mechanisms. This situation exemplifies an attitude–behavior gap, wherein knowledge of waste reduction principles does not translate into consistent practice. However, the gap appears to be institutional rather than purely cognitive, aligning with studies demonstrating that awareness alone is insufficient to induce sustained pro-environmental behavior in university settings without supportive governance and environmental cues [30].

Technical capacity constraints significantly influence the efficacy of the waste management system. Data on waste composition reveal that organic waste comprises a substantial portion of total waste generation. However, observations at the composting facility indicate that the current infrastructure is inadequate to process the entire volume generated daily. Operations at the TPS3R facility are predominantly manual, storage capacity is limited, and mechanical sorting technologies, such as Material Recovery Facilities (MRFs), are absent. An operational staff member noted that "only part of the organic waste can be composted, while the rest is sent to the landfill." These limitations corroborate previous findings that inadequate technological capacity constitutes a structural barrier to enhancing material recovery rates in educational institutions and urban areas within developing-country contexts [8].

The final theme pertains to the insufficient integration of environmental culture across campus units. Interview data reveal that many students and staff possess only a limited understanding of waste classification and the critical importance of source separation. Environmental education initiatives are characterized as sporadic and not systematically incorporated into curricula or routine institutional activities. As one faculty member noted, "sustainability is discussed occasionally, but it is not part of everyday academic practice." This observation suggests that sustainability values have not yet been internalized as shared institutional norms. Prior research underscores that enduring sustainability transitions in higher education necessitate the integration of regulatory frameworks, education, daily practices, and collective engagement to foster a robust environmental culture [31].

Collectively, these four themes elucidate a coherent pattern of systemic challenges. Fragmented institutional coordination undermines policy implementation, behavioral practices compromise the quality of source segregation, technical limitations restrict processing capacity, and a deficient environmental culture impedes long-term change. This convergence of findings suggests that the waste management challenges at Hasanuddin University cannot be resolved through isolated technical interventions alone but necessitate a multidimensional governance approach. These insights form the empirical foundation for the proposed five-dimensional waste governance model presented in the subsequent section.

3.3. Integrated Interpretation and Circular Opportunities

The synthesis of thematic findings indicates that the interplay of institutional governance, behavioral practices, technical capacity, and environmental culture influences waste management performance at Hasanuddin University. These factors do not function as isolated constraints; rather, they reinforce one another and collectively impact the effectiveness of Integrated Solid Waste Management (ISWM) implementation. Fragmented institutional coordination undermines policy enforcement, behavioral gaps diminish the efficacy of source segregation, technical limitations restrict material recovery, and a weakly embedded environmental culture hinders long-term transformation. Similar interdependencies have been observed in higher education institutions within developing-country contexts, where sustainability initiatives often face challenges due to misalignment between governance structures and operational practices [8,29].

Significantly, the conditions that pose challenges also offer opportunities for advancing circular waste management on campus. The prevalence of organic waste, for example, presents a distinct opportunity to expand composting initiatives. In contrast, the existing waste bank infrastructure serves as a foundation for enhancing the recovery of recyclable materials. However, capitalizing on these opportunities necessitates strategic integration across institutional, technical, and behavioral dimensions, rather than relying solely on incremental technical upgrades. Table 1 provides a summary of the key challenges identified in this study, alongside corresponding circular opportunities and strategic responses.

From a feasibility standpoint, interventions focused on institutional coordination and environmental literacy are low-cost and can be implemented in the short term, contingent upon leadership commitment and regulatory clarity. Conversely, technological interventions, such as the expansion of composting infrastructure or the introduction of mechanical sorting facilities, necessitate higher capital investment and technical expertise, thereby presenting moderate financial and operational risks. These risks align with findings from previous studies, which indicate that technological upgrades in Integrated Solid Waste Management (ISWM) systems are frequently constrained by funding limitations and maintenance capacity in developing contexts [8,22].

Behavioral interventions, including the bin-removal policy observed at Unhas, represent a potentially effective but context-sensitive strategy. While field observations indicate improved cleanliness and waste discipline in selected areas, the long-term effectiveness of such measures depends on parallel investments in environmental education, accessible disposal alternatives, and consistent enforcement. Without these complementary measures, there is a risk that behavioral interventions may displace waste rather than reduce it, as documented in comparable institutional settings [17].

The comprehensive analysis of challenges and opportunities highlights the imperative for a multidimensional governance strategy in campus waste management. The feasibility assessment indicates that a phased implementation, commencing with governance reform and behavioral empowerment, followed by targeted technical investments, presents a pragmatic approach to achieving circular campus transitions. These findings directly inform the development of the proposed five-dimensional waste governance model, which aims to harmonize regulatory frameworks, institutional arrangements, financial mechanisms, empowerment strategies, and technical systems within a coherent Integrated Solid Waste Management (ISWM) framework.

Table 1. Challenges and Circular Opportunities in Campus Waste Management at Hasanuddin University

Key Dimension	Identified Challenges	Circular Opportunities	Feasibility and Risk Considerations
Institutional governance	Fragmented coordination across campus units; unclear enforcement mechanisms	Establishment of cross-unit SOPs and a centralized waste governance body	High feasibility; risk of resistance due to institutional inertia
Behavioral practices	Low compliance with source segregation; reliance on cleaning staff	Targeted environmental literacy and behavioral nudging programs	Moderate feasibility; risk of limited impact without incentives
Technical capacity	Limited composting capacity; absence of mechanical sorting facilities	Expansion of composting units and gradual introduction of MRFs	Moderate feasibility; financial and maintenance constraints
Financial mechanisms	Limited dedicated funding for waste management	Revenue generation through waste bank optimization and compost sales	Moderate feasibility; market volatility risk
Environmental culture	Sustainability not embedded in daily academic practices	Integration of waste education into curricula and campus routines	High feasibility; requires long-term commitment

3.4. Regulatory, Institutional, Technical, Financial, and Empowerment

Implementing sustainable waste management at Hasanuddin University necessitates a comprehensive policy approach that integrates regulatory, institutional, technical, financial, and empowerment dimensions within a cohesive governance framework. From a regulatory standpoint, although national waste legislation and internal university guidelines exist, their implementation remains fragmented across campus units. Enhancing regulatory effectiveness thus requires the formalization of a binding Rector's Regulation, supported by cross-unit Standard Operating Procedures (SOPs) that clearly delineate roles, performance indicators, and enforcement mechanisms. International experiences from institutions such as the University of Tokyo and Wageningen University illustrate that centralized regulatory frameworks can significantly enhance compliance and coordination when sustainability policies are embedded within institutional planning systems and aligned with Sustainable Development Goals, particularly SDG 11 and SDG 12 [14,15,32].

Institutionally, the study emphasizes that inadequate coordination among the Directorate of Facilities Management and Maintenance (DFMM), faculties, laboratories, and academic units compromises consistent waste management practices, particularly at the point of source segregation. The lack of a centralized governance mechanism has led to inconsistent policy implementation, despite the presence of formal regulations. Establishing an integrated campus waste governance unit or task force with cross-unit representation could improve coordination, monitoring, and accountability. Previous research highlights that leadership commitment and institutional integration are critical factors in achieving effective campus sustainability outcomes, as fragmented responsibility often diminishes the impact of technical and behavioral interventions [11,33].

From a technical perspective, the limited capacity of current waste processing infrastructure constitutes a significant impediment to the implementation of Integrated Solid Waste Management (ISWM) principles. Although composting facilities are operational, their existing capacity is inadequate to process the predominant organic waste fraction generated on campus [12]. Expanding composting infrastructure necessitates investment in equipment, land allocation, trained personnel, and operational planning to ensure process stability and product quality. Similarly, the establishment of Material Recovery Facilities (MRFs) could enhance the efficiency and quality of recyclable material recovery. However, empirical studies indicate that MRF implementation entails substantial capital expenditure, ongoing maintenance costs, and skilled labor requirements, which often present financial and operational challenges in developing-country contexts [8,24]. Therefore, a phased and pilot-based implementation strategy is recommended to mitigate financial risk and ensure technical feasibility.

Financial considerations significantly influence the sustainability of campus waste management initiatives. Although waste banks offer potential revenue through the sale of recyclable materials, these income streams are susceptible to market volatility and variations in material quality. Evidence from universities that have effectively implemented circular economy models indicates that financial sustainability is enhanced when waste management initiatives are supported by dedicated institutional budgets and supplemented by cost-recovery mechanisms, such as compost sales, service fees, or collaborations with municipal authorities and the private sector [34]. However, relying solely on revenue generated from waste is inadequate for sustaining long-term operations, underscoring the necessity for stable funding allocations within university financial planning.

Both empowerment and behavioral dimensions are crucial for the effectiveness of policy implementation. The ongoing issue of low compliance with source segregation indicates that environmental awareness alone is insufficient to ensure consistent waste management practices. Incorporating environmental literacy into educational curricula, student orientation programs, and staff training can promote normative commitment and a collective sense of responsibility for waste reduction. Empirical evidence from higher education institutions that have adopted student-led initiatives and sustainability ambassador programs suggests that empowerment-based strategies can enhance participation and ownership within campus communities [35,36]. Behavioral interventions, such as the bin-removal policy observed at Hasanuddin University, may further strengthen waste discipline through nudging mechanisms; however, their success is contingent upon the availability of alternative disposal options, consistent institutional messaging, and concurrent educational efforts [17,37].

In summary, the policy and sustainability implications highlight the imperative for a comprehensive and integrated approach to campus waste governance. It is essential to implement regulatory clarity, institutional coordination, technical capacity, financial sustainability, and empowerment strategies cohesively to prevent fragmented and transient interventions. International experiences indicate that successful transitions in campus waste management are not achieved through isolated technical solutions but rather through governance frameworks that harmonize policy, behavior, infrastructure, and financial mechanisms. Within this context, the proposed five-dimensional waste governance model provides a practical and adaptable framework for facilitating sustainable and circular waste management transitions at Hasanuddin University and other public higher education institutions in Indonesia and the Global South.

4. Conclusions

This study illustrates that waste management at Hasanuddin University (Unhas) is experiencing a significant transition from a traditional collect–transport–dispose model to a more integrated and sustainability-focused system. Despite the presence of essential structural components such as composting units, waste banks, and selective bins, their effectiveness is hindered by fragmented institutional coordination, inconsistent source-segregation practices, limited technical capacity, and a weakly ingrained environmental culture. These interconnected constraints collectively diminish material recovery efficiency and perpetuate reliance on landfill disposal, indicating that infrastructural provision alone is inadequate for achieving Integrated Solid Waste Management (ISWM).

A central contribution of this study is the development of a five-dimensional waste governance model encompassing regulatory, institutional, financial, empowerment, and technical–technological dimensions. The findings suggest that enhancing regulatory clarity through binding institutional policies, improving cross-unit coordination, and ensuring stable financial support are prerequisites for effective ISWM implementation. Equally important are empowerment-oriented strategies that enhance environmental literacy and behavioral engagement among students, faculty, and staff, as well as targeted investments in waste processing technologies, particularly composting expansion and mechanical sorting systems.

The study also identifies practical opportunities for advancing circular waste management on campus, including scaling up composting to address the dominant organic waste fraction, optimizing waste bank operations to improve recyclable recovery, and applying behavioral interventions such as bin-removal policies to reinforce disposal discipline. However, the long-term effectiveness of these measures depends on their integration within a coherent governance framework that aligns institutional leadership, user behavior, and technical capacity.

Future research should move beyond descriptive assessments by incorporating more specific and methodologically diverse approaches. These include controlled behavioral experiments to evaluate the effectiveness of nudging and incentive-based interventions, longitudinal studies to capture changes in institutional practices and user behavior over time, and quantitative impact modeling to assess the environmental and economic benefits of ISWM and circular strategies at the campus scale. Such approaches would strengthen the empirical foundation for sustainable waste governance in higher education institutions, particularly within the Global South.

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