

# Analysis on the Role of Academia in Optimizing Waste Management in Higher Education Institutions

Karmila Suryani<sup>1</sup>, Inna Kholidasari<sup>2</sup>, Yulcherlina<sup>3\*</sup>, Popi Fauziati<sup>4</sup>, Mohd Saidin Misnan<sup>5\*</sup>, Putu Sudira<sup>6</sup>

<sup>1</sup>Bung Hatta University, Informatics and Computer Engineering Education Faculty of Teacher Training and Education Jalan Sumatera Ulak Karang, 25134, Indonesia

<sup>2</sup>Bung Hatta University, Industrial Engineering Faculty of Industrial Engineering Jalan Sumatera Ulak Karang, 25134, Indonesia

<sup>3</sup>Bung Hatta University, Civil Engineering Faculty of Civil Engineering and Planning Jalan Sumatera Ulak Karang, 25134, Indonesia

<sup>4</sup>Bung Hatta University, Accounting Faculty of Economics and Business Jalan Sumatera Ulak Karang, 25134, Indonesia

<sup>5</sup>Department of Quantity Surveying, Faculty of Built Environment and Surveying, University Technology Malaysia, 81310 Johor Bahru, Johor, Malaysia

<sup>6</sup>Universitas Negeri Yogyakarta Department of PTEI Faculty of Engineering Complex Faculty of Engineering Karang Malang Campus, Yogyakarta, 55281 Indonesia

**\*\*Corresponding Author**

DOI: <https://dx.doi.org/10.47772/IJRISS.2024.8120110>

Received: 26 November 2024; Accepted: 05 December 2024; Published: 04 January 2025

## ABSTRACT

This study aims to (1) identify the requirements for developing a waste bank and key aspects to consider in waste management; (2) produce a flowchart of the waste management system within campus environments; and (3) develop a waste management framework for campuses. The research method used is qualitative descriptive analysis, involving data collection, data analysis, and conclusion drawing. Respondents included the Head of the Waste Management Unit at Bung Hatta University, the Head of the Waste Management Unit at Andalas University, students, cleaning staff, and faculty members. The findings of the study are (1) the identification of waste management needs through the waste bank unit, including institutional, facility, and documentation requirements; (2) the development of a waste management framework via the waste bank; and (3) the establishment of a waste management flowchart for higher education institutions.

**Keywords:** Waste, management, waste bank, Higher Education

## INTRODUCTION

The increasing amount of waste produced daily aligns with population growth, consumption patterns, and societal lifestyles (Gilbert et al., 2021). Waste has become one of the most urgent global issues to address, especially for productive waste generators, which can pose serious challenges to society (Ferronato et al., 2022). One significant source of waste is higher education institutions, where the environment includes a population of students, faculty members, academic staff, employees, and cleaning staff (Sanchez-Gutierrez, 2021; Torrijos et al., 2021)

As centres of academic and social activities, campuses generate around 2 tons of waste daily. This waste includes organic waste, such as food scraps and plant material, as well as inorganic waste, such as general non-degradable waste, which includes paper and plastic packaging (Batubara et al., 2022; Ibnul Rasidi et al., 2022). If not managed properly, waste can accumulate, leading to cleanliness, health, and environmental pollution issues, which ultimately reduce productivity and disrupt the learning process in campus areas (Moraga et al., 2019).

## LITERATURE REVIEW

A conducive campus environment, in terms of academic atmosphere, layout, and cleanliness, can motivate students, faculty, and educational staff to engage in academic activities more effectively (Pascawati et al., 2023; Gandasari et al., 2020). One effort to create a conducive campus environment is by implementing waste management in campus areas (Viareco et al., 2023; Baidya et al., 2020). Developing waste management systems on campus is important and urgently needed. One effective way to manage waste, especially on campuses, is by implementing a waste bank (Fatmawati et al., 2022). A waste bank is a waste management system that involves active community participation to collect, sort, and recycle waste (Mawaddah & Putra, 2022)(Yusuf et al., 2022). This concept functions like a regular bank, where people deposit recyclable waste at the waste bank and receive certain rewards or benefits in return (Savira Ersas et al., 2023). This approach not only aims to reduce the amount of waste on campus but also empowers the community to increase environmental awareness and earn additional income (Rashid Purnomo et al., 2021). Implementing a waste bank system on campus can serve as a positive, practical example of social and environmental responsibility (Nugroho, 2022). By involving both the campus community and surrounding residents in waste management, awareness of cleanliness and environmental preservation can increase (Harper et al., 2019; Yusof and Misnan, 2019a). This aligns with one of the goals of education: to foster a community that is responsible and environmentally conscious (Chisholm et al., 2021). Additionally, a campus waste bank serves not only as a waste processing system but also as an educational tool and a research object, such as for studying the effectiveness of waste management, recycling innovations, and the socio-economic impacts of waste management within an academic environment (Yandri et al., 2023; Knäble et al., 2022).

Moreover, managing waste through a campus waste bank offers both economic and sustainable value. By sorting and recycling waste, a campus can reduce waste management costs and decrease the need for landfill use (Sulistiyorini & Demiyati, 2023). Additionally, proceeds from the sale of processed waste products can support campus activities. Organic waste, plastic, paper, and metal can be processed and reused (Suwignyo et al., 2021). Proper waste management can transform waste into valuable raw materials, supporting the local economy and creating job opportunities (Sengupta et al., 2023). Another significant benefit is that the campus can gain recognition as an environmentally friendly institution, known as a “Green Campus” (Gandasari et al., 2020; Abakumov & Beresten, 2023) Abakumov & Beresten, 2023; Yusof and Misnan, 2019b). The campus plays a significant role in addressing global challenges and environmental degradation by creating a sustainable campus environment through a Green Campus approach, integrating academic, social, economic, and environmental aspects into campus operations (Viareco et al., 2023; Torrijos et al., 2021). This study is a case study conducted at several universities implementing waste bank systems in their waste management practices. The study aims to analyse the effectiveness of the waste bank management system on campus by:

1. Identifying the requirements and aspects to consider when establishing a waste bank as a waste management system in the campus environment.
2. Producing a flowchart of the campus waste management system.
3. Developing a waste management framework for the campus environment.

## RESEARCH METHODOLOGY

### Data Collection

This study focuses on a case study from two campuses at universities in Padang City, namely Proklamator II Campus of Bung Hatta University and Limau Manis Campus of Andalas University. Data collection was

conducted through direct observation at the research sites to understand and explore conditions related to knowledge and community perceptions of waste. Subsequently, interviews were conducted with stakeholders involved in waste management on campus. Interview respondents included one Head of the Waste Management Unit at Bung Hatta University, one Head of the Waste Management Unit at Andalas University, 11 students, 32 cleaning staff, and 7 faculty members. An interview guide was prepared, containing a list of both general questions about waste management and specific questions tailored to the roles of stakeholders in the campus waste management system. Data collection was also conducted through the distribution of public perception questionnaires on waste, waste management and circular economy. Before the questionnaire was given to the research sample, validation of each statement item written in the questionnaire and its reliability was first carried out.

## DATA ANALYSIS

Analysis on Interview Data and a Public Perception Questionnaire on Waste, Waste Management and the Circular Economy Interview transcripts were created based on the interview results. A thematic analysis was then conducted to identify issues relevant to the research objectives. Thematic analysis involves identifying groups of keywords that serve as a guide for developing a waste management flow through the campus waste bank system. The resulting flow is a crucial component in building a waste management framework for the campus environment and surrounding community, achieving the study's first objective. The needs analysis and essential aspects for establishing a waste bank as a waste management system on campus will be identified through the previously developed flow and framework, contributing to the study's second objective. The validity analysis of the research questionnaire was conducted to determine the extent to which the questionnaire was able to reflect the contents according to the things and characteristics being measured. This means that each questionnaire item has truly described the entire contents or characteristics that are the basis for compiling the questionnaire. Validity testing was only conducted on the Community perception questionnaire about waste, waste management and the concept of a circular economy. The formula for the validity of the questionnaire items is as follows:

### Product Moment Correlation Formula:

$$r = \frac{[n(\sum xy) - (\sum x)(\sum y)]}{\sqrt{\{[n(\sum x^2) - (\sum x)^2][n(\sum y^2) - (\sum y)^2]\}}}$$

### Description:

r = correlation coefficient

x = item score

y = total score

n = number of respondents

### The validity criteria are like Table 1.

| No | Nilai Alpha | Keterangan         |
|----|-------------|--------------------|
| 1  | 0,00 - 0,20 | Very low validity  |
| 2  | 0,20 - 0,40 | Low validity       |
| 3  | 0,40 - 0,60 | Medium validity    |
| 4  | 0,60 - 0,80 | High validity      |
| 5  | 0,80 - 1,00 | Very high validity |

### Testing Conditions:

r count > r table = Valid

r count < r table = Invalid

Requirements:

Using a significance level of 5%

Comparing r count with r table

Reliability analysis using the Cronbach alpha coefficient formula, which aims to ensure the consistency of the assessment with the formula (Wahyuning, S., 2021)

$$r_{11} = \left( \frac{n}{n-1} \right) \left( 1 - \frac{\sum \sigma_t^2}{\sigma_t^2} \right)$$

**Description**

r<sub>11</sub>: reliability sought

n: number of test items tested

∑σ<sub>t</sub><sup>2</sup>: total variance of each item score

σ<sub>t</sub><sup>2</sup>: total variance

**The reliability coefficient criteria are as in the Table 2**

| No | Nilai Alpha | Keterangan            |
|----|-------------|-----------------------|
| 1  | > 0,90      | Very high reliability |
| 2  | 0,70 – 0,90 | High reliability      |
| 3  | 0,50 – 0,69 | Moderat reliability   |
| 4  | 0,20 – 0,49 | Low reliability       |
| 5  | ≤ 0,19      | No reliable           |

To measure academic perceptions regarding waste, waste management and the concept of circular economy using descriptive analysis with percentages such as the following formula:

$$X = \frac{\text{Number of scores obtained}}{\text{Highest score number}} \times 100\%$$

**Identifying the Needs of the Waste Bank System**

To establish a waste bank on campus, various preparations are required, including rules and procedures, documentation, organizational structure, and other waste bank facilities such as equipment and buildings. These needs can be identified from the waste management flow derived from the interview analysis conducted using thematic analysis.

**Designing a Waste Bank Management Framework in Higher Education Institution**

The framework for waste bank management is derived from the waste management flow and the requirements that must be met in establishing and operating a waste bank on campus. This framework provides an overview of the mindset needed for waste management within a campus environment through a waste bank system.

**Socialization and Education on Waste Management for Cleaners, Lecturers, Educational Staff, and Students**

The results of data processing and analysis from the previous research stages in the form of a framework, process flow, and the needs required in waste management were socialized to residents in the campus environment such as lecturers, students, education staff, and campus cleaners. As an initial stage of socialization, residents in the campus environment were asked to inform their knowledge and insights about the activities carried out on their daily waste such as waste sorting, the selling value of waste (economically valuable waste), the desire to participate in waste management. With this socialization and education, it is hoped that residents in the campus environment will better understand and participate in becoming waste bank customers who will later support the circular economy program promoted by the government.

## Summarize the Results of Data Analysis

The final stage of the research is to draw conclusions from the results of the analysis and design of the waste management framework.

## RESULTS AND DISCUSSION

### Thematic Analysis Results

Contents Analysis of Interview Results from various universities in West Sumatra shown in Table 3.

**Table 3. Content Analysis of Interview**

| Interview Data  | 1st Order Grouping                                | 2nd Order Grouping  |
|---|---|---------------------|
| from 2014 to 2019 we had a decree from the Rector every year  | Institution Agency Legality                       | Institutional Needs |
| we are responsible to the Second Vice Rector.   | Organisational Structure                          | Institutional Needs |
| There was also a housekeeping department if I'm not mistaken, so we can collaborate with them...  | Organisational Structure                          | Institutional Needs |
| But afterwards, because the lecturers were no longer involved, the Intergrated Waste Processing Centre (PPST) at Andalas University only acts as a coordinator. | Organisational Structure                          | Institutional Needs |
| The head of the PPST is assisted by only two directors, the Operational Director and the Finance and Marketing Director   | Organisational Structure                          | Institutional Needs |
| under the Operational Director, there is coordinator appointed to oversee the PPST.   | Organisational Structure and Coordinator's Duties | Institutional Needs |
| under the coordinator, there are waste bank officers, waste bank employees, and 10 compost personnel.   | Organisational Structure and Coordinator's Duties | Institutional Needs |
| so, there are motor carts.  | Equipment   | Facility Needs      |
| the PPST staff take the leaves in the yard that the cleaning staff have swept into sacks.   | Equipment Consumables                             | Facility Needs      |
| sometimes we have to wait a long time for the trucks...   | Fleet/Vehicles                                    | Facility Needs      |

| Interview Data  | 1st Order Grouping                    | 2nd Order Grouping        |
|---|---------------------------------------|---------------------------|
| The PPST is near the campus bus depot   | Building Space                        | Facility Needs            |
| This SOP was in 2017, if I'm not mistaken, a decree was issued by the Rector to create a Waste Management SOP   | Procedural Document                   | Procedural Document Needs |
| The waste management SOP means we start from the waste source and continue with the necessary steps.  | Management Process                    | Management Flow           |
| for example, how many waste containers are available...   | Equipment                             | Facility Needs            |
| We start by dividing waste into four types...easily decomposed waste like compost, reusable and recyclable waste, hazardous waste (B3), and other types of waste.   | Management Process<br>(Sorting Waste) | Management Flow           |
| The management varies, easily decomposed waste goes to the compost house and waste bank. Reusable and recyclable waste goes to the waste bank. Hazardous waste goes to the university hospital, which has a storage area for hazardous waste. Other types of rubbish go into containers and taken to the landfill | Management Process                    | Management Flow           |
| The compost house produces not only compost but also pellets from leaf waste to be used as biomass to replace coal.   | Processing and Product                | Management Flow           |
| At the waste bank, we received a plastic shredder   | Machinery Equipment                   | Facility Needs            |
| bottles, cups and plastic are separated because the selling price varies; the shape of bottle and cups are also different, the labels and caps are removed.   | Management Process                    | Management Flow           |
| an SOP specifically for plastic waste management has been prepared  | Procedural Document                   | Procedural Document Needs |
| data is recorded for waste received/deposited by clients, with reports generated according to the SOP.  | Procedural Document                   | Procedural Document Needs |
| at that time, we bought a laptop to create  | Administrative Equipment              | Facility Needs            |



| Interview Data  | 1st Order Grouping             | 2nd Order Grouping        |
|---|--------------------------------|---------------------------|
| an application...   |                                |                           |
| there is a waste bank building.   | Building Space                 | Facility Needs            |
| there are scales, tables, chairs, sacks, motor carts...                           | Equipment                      | Facility Needs            |
| Semen Padang only take pellets from plants, we sell the plastic to a collector... | Management Process             | Management Flow           |
| usually, this report is monthly.  | Report Document                | Procedural Document Needs |
| we need a press machine...  | Equipment                      | Facility Needs            |
| on campus, regulations specify separating reusable and recyclable waste...        | Regulatory Document            | Procedural Document Needs |
| for the waste bank, the profit-sharing ratio is eighty-five/fifteen               | WasteBank Management Procedure | Procedural Document Needs |
| later the passbook, printing the passbook   | Administrative Equipment       | Kebutuhan Fasilitas       |

From the content analysis, the requirements for establishing a campus waste bank can be grouped as follows:

### Institutional Needs

- A Waste Management Unit within the campus, legalized by the institution's leadership.
- An organizational structure with clear roles and responsibilities.

### Documentation Needs

The documents required to establish a waste management unit in higher education include a Waste Management Team Decree issued by the institution's leadership and a Standard Operational Procedure (SOP) consisting of:

- SOP for Waste Bank Client Registration
- SOP for Waste Sorting
- SOP for Waste Weighing
- SOP for Waste Bank Transactions
- SOP for Waste Processing for each type of waste.
- Waste Bank Management Report

### Facility Needs:

Required facilities include a building/room, a fleet/vehicle such as a truck/pick-up vehicle and motor cart, and machinery and equipment such as:

- Waste Containers
- Sacks
- Scales
- Plastic Shredding Machine
- Stationery

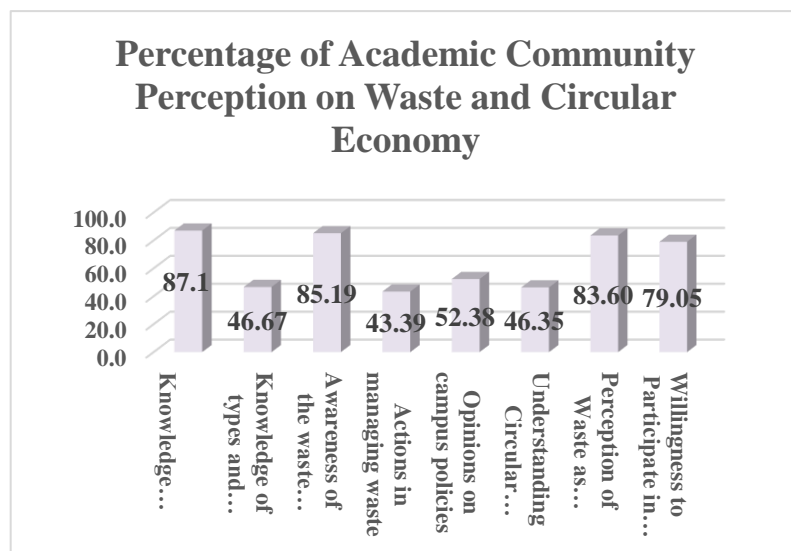
- Tables
- Chairs
- Laptop/Computer
- Press Machine

Needs Analysis and Aspects Required for Establishing a Campus Waste Bank (this list was gathered during the grant proposal meeting and can be adjusted accordingly): a) Legality and permits, covering operational permits from the campus and the legal structure from the foundation; b) choosing a strategic location to facilitate transactions at the waste bank and providing storage facilities and equipment such as scales, waste separators, containers, and cleaning equipment; c) socialization within the academic community regarding the campus waste bank, along with education related to reduction, reuse, and recycling; d) creating a clear and transparent system for waste collection, sorting, and management, as well as a structured recording and reporting process; e) determining initial funding sources, potential revenue, and establishing partnerships with various recycling companies, creative industries, and government agencies.

### Results of Research Questionnaire Analysis

The analysis of the research questionnaire began by testing the validity of the statement items with the results showing that all statement items were declared valid as evidenced by the value of  $0,6 > 0,25$ . Furthermore, the questionnaire that had been declared valid was subjected to reliability analysis with the results 0,849 (High reliability).

The results of the public perception questionnaire analysis regarding waste, management and the circular economy are as shown in Figure 1.



**Figure 1. Percentage of Research Questionnaire Results**

Based on the Figure 1 it can be seen that lecturers, students, CS and all academics in universities already understand about waste, but have not been able to manage and type waste. Academic awareness of the dangers caused by waste accumulation is quite high but academics have not been able to take action to manage the waste, this can be seen from the results of the questionnaire obtained below 50%. Academics already understand that waste can be recycled and has economic value so that a circular economy occurs, university policies regarding waste management and circular economy are still low. Therefore, it is necessary to change the academic paradigm regarding waste and support from universities regarding waste management and circular economy on campus.

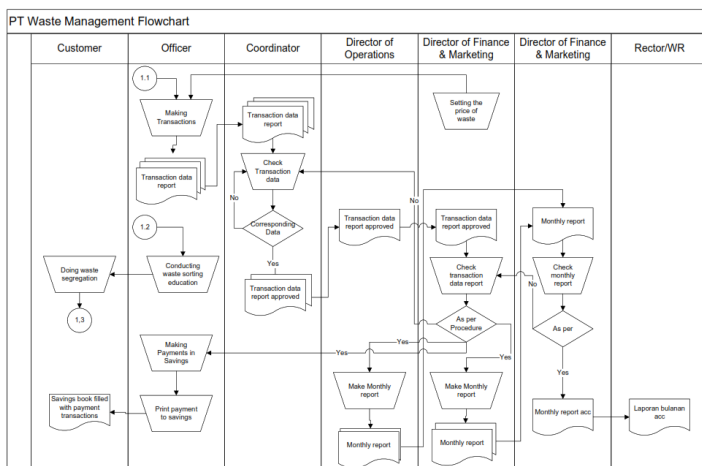
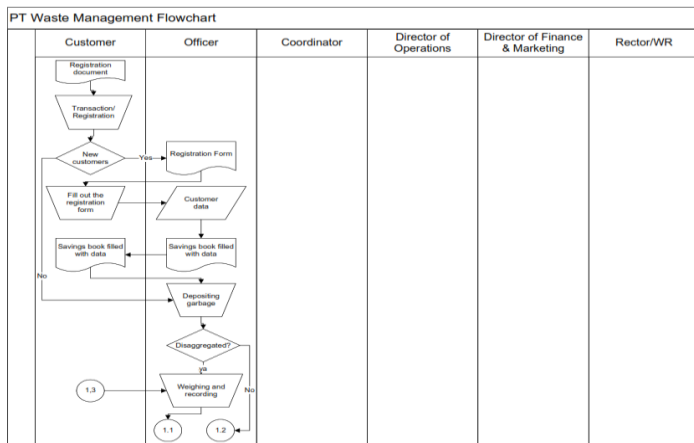
Circular economy in the campus environment can be done by recycling waste so that it has economic value. Recycling is an activity to make the best possible use of waste that cannot be used directly through an



intervention process so that it can be reused as raw materials as mentioned by Zamroni (2020). The academic community from students and lecturers can compile various waste recycling programs, such as: processing organic waste into compost, making bio pores in the campus area, recycling paper waste or selling recyclable plastic waste to third parties because in the current digital era there are many environmental care movements with the help of technology.

### Campus Waste Management Flow

The flowchart of waste management through the waste bank is depicted in the flowchart as shown in Figure 2.



**Figure 2: Flow of Waste Management Through Waste Bank**

Based on Figure 2, it can be seen that the actors involved are clients, staff, coordinators, the operational director, the finance and marketing director, and the Rector/Vice Rector as the responsible authority. The first process is carried out by the client, who can register and conduct transactions. If the client is new, they must register, during which the staff provides a registration form to be filled out. The completed data is then entered into the new client record by the staff, who subsequently creates a savings book that is given to the client. If the client is a returning client, they can directly deposit waste at the waste bank unit. The staff checks the waste submitted by the client to see if it has been sorted. If the waste is already sorted, the staff proceeds with weighing and recording the transaction, then creates a transaction report. If the waste has not been sorted, the staff educates the client about waste sorting, after which the client sorts their waste and resubmits it. Next, the staff prepares the transaction report and submits it to the coordinator for verification.

The coordinator checks the report; if it is accurate, it is forwarded to the operational director to track the progress of transactions at the waste bank. If there are discrepancies, the coordinator double-checks the transaction data report submitted by the staff. The operational director forwards the approved report to the finance and marketing director for procedure verification. If the procedures are correct, the finance and

marketing director prepares a monthly report, which is then submitted to the managing director and staff so that the staff can update the savings book. The staff records the payment in the savings book and hands it to the client, who then receives the updated savings book. If the report sent by the coordinator does not meet the procedure standards, the coordinator rechecks the transaction procedure reported. The operational director and the finance and marketing director compile a monthly report. Once the monthly report reaches the managing director, it undergoes verification. If the report is approved, the managing director signs it off and sends it to the Rector/Vice Rector.

### Campus Waste Management Framework

The Campus Waste Management Framework is shown in Figure 3.

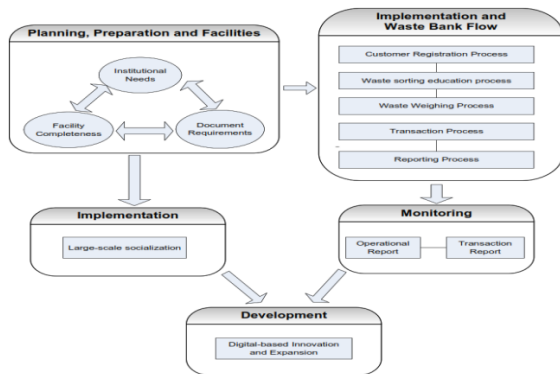


Figure 3. Framework for Waste Management on Campus

Based on Figure 3, the stages in waste management are as follows

Planning from the constant analysis, the requirements for establishing a waste bank on campus can be grouped shown in Table 4.

Table 4 Requirements for the Campus Waste Management Unit

| No | Requirement   | Function  |
|----|---|---|
| 1  | Institutional Needs:  | <ul style="list-style-type: none"> <li>The Campus Waste Management Unit must be formally recognized and approved by the institution's leadership, such as the rector or dean.</li> <li>This formalization is essential to ensure the unit has the authority and institutional support necessary to carry out its tasks. Official documents like decrees or campus regulations may be required to legitimize the unit.</li> <li>A clear organizational structure with defined roles and responsibilities. This structure should include various roles necessary for the waste bank's operations, such as Manager, Coordinator, Operational Director, Financial Director, Waste Sorting Staff. Each position should have a clear job description to avoid overlap or confusion in decision-making, and the structure should be communicated to all team members and relevant stakeholders.</li> </ul> |
| 2  | Documentation Requirements:   |   |
|    | 2.1 Decree on Waste Management Team issued by the institution's leadership. | A formal document that establishes the organizational structure, responsibilities, and legal basis for waste management activities at the village or institutional level. This decree aims to ensure effective and sustainable waste  |

| No | Requirement                                  | Function  |
|----|--|---|
|    |  | management, supporting efforts to maintain environmental cleanliness.   |
|    | 2.2 Standard Operational Procedure (SOP)     |   |
|    | 2.2.1 SOP for Waste Bank Client Registration | <ul style="list-style-type: none"> <li>• Ensures a consistent registration process for new clients at the campus waste bank</li> <li>• Operational efficiency: SOPs make the registration process more structured and efficient, reducing the time needed to register new clients and maximizing staff productivity.</li> <li>• Regulatory compliance: SOPs ensure that the registration process complies with university regulations related to waste management.</li> <li>• Service quality: With clear procedures, waste bank staff can provide consistent and high-quality service to prospective clients, improving user satisfaction.</li> <li>• Data accuracy: SOPs help ensure that all necessary client information is collected accurately for waste bank management.</li> <li>• Client education: The registration process educates new clients about the waste bank concept and its role in campus waste management.</li> <li>• Monitoring and evaluation: SOPs provide clear criteria to monitor and evaluate the effectiveness of the registration process for continuous improvement.</li> <li>• Support sustainability: Good registration SOPs support the university's sustainability goals by ensuring active campus community participation in waste management.</li> <li>• Foundation for development: SOPs can be the basis for future waste bank system development, including potential digitization of the registration process.</li> </ul> |
|    | 2.2.2 SOP for Waste Sortin                   | <ul style="list-style-type: none"> <li>• Standardizes waste sorting processes, ensuring consistency in handling various types of waste across campus.</li> <li>• Optimizes recycling: Proper sorting maximizes recycling potential and reuse of materials, supporting a circular economy on campus.</li> <li>• Management efficiency: Structured waste sorting improves waste processing and management efficiency, saving time and resources.</li> <li>• Educates the campus community on the importance and proper methods of sorting waste.</li> <li>• Encouraging Cleanliness: Contributes to campus cleanliness and aesthetics.</li> <li>• Reduces landfill waste: Effective sorting reduces waste sent to landfills.</li> <li>• Research support: Waste sorting data can be used for research and development in waste management and sustainability.</li> <li>• Increases economic value: Proper sorting increases the economic value of recyclable waste.</li> <li>• Record-keeping and reporting: Facilitates accurate</li> </ul>  |

| No | Requirement                                 | Function  |
|----|---|---|
|    |   | <p>records on waste volume and type for reporting and planning.</p> <ul style="list-style-type: none"> <li>• Fosters environmental awareness in the academic community.</li> <li>• Basis for evaluation and improvement: Provides a framework for regular evaluation and improvement of campus waste management.</li> </ul>   |
|    | <p>2.2.3 SOP for Waste Weighing</p>         | <ul style="list-style-type: none"> <li>• Ensures accurate and consistent weighing of waste, essential for calculating waste value.</li> <li>• Standardizes the weighing process, so each staff member follows the same procedure.</li> <li>• Provides transparency in the weighing process between clients and the waste bank, building trust.</li> <li>• Optimizes the weighing process to save time and resources.</li> <li>• Facilitates accurate records of waste volume and type, important for reporting and analysis.</li> <li>• Inventory management: Helps manage recyclable or sellable waste stock.</li> <li>• Educates clients about the economic value of the waste they collect.</li> <li>• Quality control: Allows checking waste quality during weighing to ensure it meets waste bank criteria.</li> <li>• Research basis: Provides data for studying waste production and consumption patterns on campus.</li> <li>• System integration: Facilitates integration of weighing data into the waste bank or broader campus digital management system.</li> <li>• Basis for program development: Weighing data can support new program development related to campus waste management.</li> </ul> |
|    | <p>2.2.4 SOP for Waste Bank Transaction</p> | <ul style="list-style-type: none"> <li>• Standardizes waste transaction procedures to ensure consistent service.</li> <li>• Financial accuracy: Ensures accurate calculation of waste value and fair payment to clients.</li> <li>• Transparency: Provides clients with clarity on transaction processes, fees, and payments.</li> <li>• Operational efficiency: Optimizes transaction processes to save time and resources.</li> <li>• Record-keeping and documentation: Essential for auditing and reporting, enabling thorough and accurate transaction records.</li> <li>• Facilitates consumer data management for updating client information related to transactions.</li> <li>• Performance evaluation basis: Provides data for evaluating consumer participation and waste bank performance.</li> <li>• Economic education: Teaches clients about the economic value of waste.</li> <li>• System integration: Allows transaction data integration into broader financial or campus management systems.</li> <li>• Reporting: Assists in creating timely and accurate</li> </ul>  |

| No | Requirement                            | Function   |
|----|--|--|
|    |  | <p>financial and operational reports.</p> <ul style="list-style-type: none"> <li>• Motivates clients: Smooth and transparent transactions may encourage continued participation in the waste bank program.</li> <li>• Basis for program development: Enables development of new programs to incentivize clients based on transaction data.</li> <li>• Trend analysis: Allows analysis of transaction patterns for insight into waste management trends.</li> </ul>   |
|    | 2.2.5 SOP for Waste Processing by Type | <ul style="list-style-type: none"> <li>• Standardizes waste processing methods for consistency and efficiency.</li> <li>• Optimizes recycling: Enhances recycling and reuse potential for various waste types.</li> <li>• Resource efficiency: Establishes best practices for using resources in waste processing.</li> <li>• Workplace safety: Creates safety protocols for handling different waste types, protecting staff and the environment.</li> <li>• Record-keeping and reporting: Facilitates accurate documentation of processed waste volume and type.</li> <li>• Educates the campus community about waste processing methods.</li> <li>• Innovation: Encourages development of more eco-friendly and efficient waste processing methods.</li> <li>• Research support: Offers a framework for research in waste processing.</li> <li>• Minimizes environmental impact: Ensures waste processing minimizes adverse environmental effects.</li> <li>• Increases economic value: Optimizes processes to increase waste's economic value.</li> </ul>  |
|    | 2.2.6 Waste Bank Management Report     | <ul style="list-style-type: none"> <li>• Performance documentation: Records all activities and achievements of the waste bank.</li> <li>• Program evaluation: Provides data to evaluate the effectiveness of the campus waste bank program.</li> <li>• Accountability: Promotes transparency and responsibility to campus stakeholders and university leadership.</li> <li>• Strategic planning: Assists in developing long-term waste bank programs and provides information for strategic decision-making on campus waste management.</li> <li>• Internal communication: Communicates waste bank performance with various university units.</li> <li>• Motivates participation: Demonstrates the benefits of campus community participation in the waste bank program.</li> <li>• Benchmarking: Provides data for comparing performance over time or with other institutions.</li> <li>• Education and awareness: Serves as an information source to raise environmental awareness among the academic community.</li> <li>• Research support: Provides data for studies on environmental sustainability and waste management.</li> </ul> |

| No | Requirement   | Function   |
|----|---|--|
|    |   | <ul style="list-style-type: none"> <li>• Policy development: Forms the basis for creating or amending campus waste management policies.</li> <li>• Continuous improvement: Forms the foundation for sustainable improvement.</li> </ul>  |
| 3  | Facility Requirements   |  |
|    | 3.3.1 Building/ Room  | <ul style="list-style-type: none"> <li>• <b>Waste storage area:</b> Used for storing collected and sorted waste before further processing or sale.</li> <li>• <b>Sorting area:</b> A designated area to sort waste by type (organic, inorganic, recyclable, etc.).</li> <li>• <b>Weighing station:</b> Where clients or students weigh their waste.</li> <li>• <b>Processing area:</b> Required if the waste bank performs basic waste processing.</li> <li>• <b>Equipment storage area:</b> Stores tools and equipment used in the waste bank operations.</li> <li>• <b>Handwashing and sanitation area:</b> Ensures waste bank staff maintain hygiene.</li> <li>• <b>Display area:</b> Exhibits recycled products or crafts made from waste, which can inspire and educate visitors.</li> </ul>  |
|    | 3.3.2 Fleet/Vehicles (such as pickup trucks and motorized carts)  | <ul style="list-style-type: none"> <li>• Waste transport: Collects waste from various campus locations and accesses hard-to-reach areas.</li> <li>• Waste distribution: Brings collected waste to the waste bank for sorting and additional processing; transports sorted waste to recycling centres or external buyers.</li> <li>• Additional equipment distribution: Delivers items like trash cans, sorting bags, or other supplies across campus units.</li> <li>• Waste bank team mobility: Enables the team to travel to different faculties or campus units for outreach or education activities.</li> <li>• <b>Product delivery:</b> Transporting processed or recycled goods to stores or exhibitions.</li> <li>• <b>Operational effectiveness:</b> Accelerates waste collection and transportation, expanding the reach of the waste bank services.</li> <li>• <b>Emergency handling:</b> Assists in handling waste that accumulates and needs to be managed promptly.</li> <li>• <b>Brand identity and visibility:</b> The waste bank logo can raise awareness of circular economy programs on campus.</li> </ul> |
|    | 3.3.4 Machine and Equipment, including: Waste containers, sacks, scales, plastic shredders, writing tools, tables, chairs, laptops/computers, press machines. |  |

The research conducted also provides an overview on the benefits of establishing a waste bank in universities, such as:

- Serving a place for knowledge development, research, and community service activities for lecturers (Pramono et al., 2023; Pramono et al., 2023).



- Supporting the creation of a Green Campus and recognition of the institution's environmental performance outside the campus, concerning clean and eco-friendly campuses and waste management procedures (Fachrudin & Fachrudin, 2021).
- Creating a conducive environment on campus that can support the success of the teaching and learning process, as well as the performance of lecturers and educational staff.
- Providing awareness and knowledge about clean and productive living to the academic community and surrounding communities.
- Becoming a source of income for both waste bank clients and the institution (Purwendah et al., 2022).
- Opening opportunities for collaboration with industry.
- Creating opportunities to obtain research and development funding from various institutions related to occupational Health, Safety, and Environmental Protection.
- In addition, this research also identified general challenges faced by Higher Education Institutions, including: Low public awareness regarding the impact of littering, and waste bank clients being accustomed to receiving direct payment for waste without saving (Knable et al., 2022).
- Limited qualified human resources for waste management on campus, both in terms of number and qualifications (Asiva Noor Rachmayani, 2023)
- Insufficient support from Higher Education leadership, with some even not supporting the establishment of the development of waste banks.
- Regulatory and procedural changes regarding waste bank management in line with changes in Higher Education leadership.

## CONCLUSION

This research has successfully identified the requirements and aspects that need attention when establishing a waste bank unit as a waste management system on campus, namely institutional needs, facility needs, and documentation needs. It produced a waste management flowchart for the campus environment, involving components such as clients (lecturers, students, cleaning staff, and educational staff), waste bank officers, coordinators, the operational director, the finance & marketing director, the general director, and the Rector, with the Vice Rector as the person in charge. The research also produced a waste management framework for the campus environment, which includes components such as planning, preparation and facilities, implementation and waste bank flow, monitoring, and further implementation and development.

## ACKNOWLEDGEMENT

This article is part of the research funded by the Directorate General of Higher Education, Research, and Technology through the Directorate of Research, Technology, and Community Service (Drtpm Ditjen Diktiristek) In 2024. Therefore, The Authors Would Like to Thank Drtpm Ditjen DIKTIRISTEK, Region X Coordinator, and Bung Hatta University for supporting the authors in conducting this research.

## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding this article

## Author Contribution

The contributions of each author are as follows: the first author wrote scientific article and collected data, the second and third author conducted data collection through interviews and data processing, while the fourth and fifth authors conducted the literature review and drafted the article.

## REFERENCES

1. Abakumov, E., & Beresten, S. (2023). Green Campus as a Part of Environmental Management of St. Petersburg State University. *Sustainability (Switzerland)*, 15(16).
2. Asiva Noor Rachmayani. (2023). Evaluasi Pelaksanaan Program Bank Sampah di Kelurahan

- Pedurungan Kidul, Kecamatan Pedurungan, Kota Semarang. 6.
3. Baidya, R., Debnath, B., Ghosh, S. K., & Rhee, S. W. (2020). Supply Chain Analysis of e-waste processing Plants in Developing Countries. *Waste Management and Research*, 38(2), 173–183.
  4. Batubara, R., Mardiansyah, R., & Sukma A.M, A. (2022). Pengadaan Tong Sampah Organik Dan Anorganik Dikelurahan Indro Kecamatan Kebomas Gresik. *DedikasiMU: Journal of Community Service*, 4(1), 101.
  5. Chisholm, J. M., Zamani, R., Negm, A. M., Said, N., Abdel daiem, M. M., Dibaj, M., & Akrami, M. (2021). Sustainable waste management of medical waste in African developing countries: A narrative review. *Waste Management and Research*, 39(9), 1149–1163.
  6. Fachrudin, H. T., & Fachrudin, K. A. (2021). The relationship between green behaviour and green campus principles: A literature review. *IOP Conference Series: Materials Science and Engineering*, 1122(1), 012028.
  7. Fatmawati Fatmawati, Mustari, N., Haerana, H., Niswaty, R., & Abdillah Abdillah. (2022). Implementasi kebijakan bank sampah melalui kolaboratif: studi banding Makassar dan Banntaeng, Indonesia.
  8. Ferronato, N., Pasinetti, R., Vargas, D. V., Mendoza, I. J. C., Lizarazu, E. G. G., Portillo, M. A. G., Conti, F., & Torretta, V. (2022). Circular Economy, International Cooperation, and Solid Waste Management: A Development Project in La Paz (Bolivia). *Sustainability (Switzerland)*, 14(3).
  9. Gandasari, I., Hotimah, O., & Miyarsah, M. (2020). Green Campus As a Concept in Creating Sustainable Campuses. *KnE Social Sciences*, 2020, 1–9.
  10. Gilbert, N., Ziqiang, Y., & Hongzhi, M. (2021). Current situation of solid waste management in East African countries and the proposal for sustainable management. *African Journal of Environmental Science and Technology*, 15(1), 1–15.
  11. Harper, G., Sommerville, R., Kendrick, E., Driscoll, L., Slater, P., Stolkin, R., Walton, A., Christensen, P., Heidrich, O., Lambert, S., Abbott, A., Ryder, K., Gaines, L., & Anderson, P. (2019). Recycling lithium-ion batteries from electric vehicles. *Nature*, 575(7781), 75–86.
  12. Ibnul Rasidi, A., Pasaribu, Y. A. H., Ziqri, A., & Adhinata, F. D. (2022). Klasifikasi Sampah Organik dan Non-Organik Menggunakan Convolutional Neural Network. *Jurnal Teknik Informatika Dan Sistem Informasi*, 8(1), 142–149.
  13. Knäble, D., de Quevedo Puente, E., Pérez-Cornejo, C., & Baumgärtler, T. (2022). The impact of the circular economy on sustainable development: A European panel data approach. *Sustainable Production and Consumption*, 34, 233–243.
  14. Mawaddah, N., & Putra, F. R. A. (2022). Identification of Waste Processing Methods in Bersinar Waste Bank Bandung, West Java. *Indonesian Journal of Environmental Management and Sustainability*, 6(1), 181–188.
  15. Moraga, G., Huysveld, S., Mathieux, F., Blengini, G. A., Alaerts, L., Van Acker, K., de Meester, S., & Dewulf, J. (2019). Circular economy indicators: What do they measure? *Resources, Conservation and Recycling*, 146(April), 452–461.
  16. Nugroho, A. (2022). WASTE BANK CONCEPT: Having Savings and Income from Waste. *Jurnal Mahasiswa Humanis*, 2(2).
  17. Pascawati, N. A., Lusiyati, E. D., Untari, J., & Ramadanti, D. P. (2023). University Readiness Analysis Towards Green Campus: A Case Study Using UI GreenMetric. *Disease Prevention and Public Health Journal*, 17(2), 149–161.
  18. Pramono, S. A., Sanggoro, H. B., & Yulianto, P. (2023). Manfaat Bank Sampah Dalam Upaya Pengendalian Sampah Domestik Di Desa Kalisalak Kabupaten Banyumas. *Jurnal Pengabdian Kepada Masyarakat*, 2(1), 169–173.
  19. Purwendah, E. K., Mangku, D. G. S., Triana, I. D. S., & Erowati, E. M. (2022). Waste bank in strengthening the healthy living community movement (GERMAS) during the COVID-19 pandemic. *International Journal of Health Sciences*, 6(2), 846–856.
  20. Rashid Purnomo, Herawati, L., & Amri, C. (2021). Terhadap Perilaku Buang Sampah Pada Tempatnya. *Kesehatan Lingkungan*, 8(3), 101–107.
  21. Sanchez-Gutierrez, F. O. (2021). Retos pos pandemia en la gestión de residuos sólidos. *CienciAmérica*, 10(1), 11–23.
  22. Savira Ersa, N., Ikhsan, M., Ilhami, T., Akbar, S., Baidhawi, B., Sayuti, M., & Fithra, H. (2023). Waste

- bank to improve sanitation community awareness in Ceubrek Pirak Village, North Aceh. Indonesia Journal of Community Service and Empowerment, 4(1), 205–212.
23. Sengupta, D., Ilankoon, I. M. S. K., Kang, K. D., & Chong, M. N. (2023). Circular economy and household e-waste management in India. Part II: A case study on informal e-waste collectors (Kabadiwalas) in India. *Minerals Engineering*, 200(May).
  24. Sulistiyorini, D., & Demiyati, C. (2023). Edukasi Pengelolaan Sampah Rumah Tangga pada Warga Sekitar Lokasi Bank Sampah Emo-G Kabupaten Bogor. *Poltekita: Jurnal Pengabdian Masyarakat*, 4(4), 928–936.
  25. Suwignyo, P., Arkananta, R. E., Singgih, M. L., Fudhla, A. F., & Juniani, A. I. (2021). Literature Review Model Circular Economy Dan Potensi Pengembangannya. *JISO : Journal of Industrial and Systems Optimization*, 4(2), 122.
  26. Torrijos, V., Calvo Dopico, D., & Soto, M. (2021). Integration of food waste composting and vegetable gardens in a university campus. *Journal of Cleaner Production*, 315.
  27. Viareco, H., Heraningsih, S. F., Ilfan, F., & Putra, T. S. (2023). Indikator Pengelolaan Sampah di Perguruan Tinggi Menggunakan Tolak Ukur Pertanyaan-Penilaian. *Jurnal Engineering*, 5(2), 106–117.
  28. Wahyuning, Sri. (2021). *Dasar-dasar Statistik*. Semarang: Yayasan Prima Agus Teknik.
  29. Yandri, P., Budi, S., & Putri, I. A. P. (2023). Waste sadaqah: a new community-based waste management practice in Java, Indonesia. *Sustainability: Science, Practice, and Policy*, 19(1).
  30. Yusuf, R., Yunus, M., Maimun, M., & Fajri, I. (2022). Environmental education: A correlational study among environmental literacy, disaster knowledge, environmental sensitivity, and clean-living behavior of post tsunami disaster in aceh communities, Indonesia. *Polish Journal of Environmental Studies*, 31(1), 411–425.
  31. Yacine Taibi, Yannick A. Metzler, Silja Bellingrath, Andreas Müller (2021) A Systematic Overview on the Risk Effects of Psychosocial Work Characteristics on Musculoskeletal Disorders, Absenteeism, and Workplace Accidents, *Applied Ergonomics*, 95, 103434
  32. Yusof, N.H & Misnan, M.S. (2019a) Relationship Between Medium and Large Grade Contractors on Implementing Safety Management in Construction Site, *International Journal of Engineering and Advanced Technology*, 8(5), 384-390
  33. Yusof, N.H & Misnan, M.S. (2019b) A Review of Safety Issues among Small Grade Contractors in Construction Industry, *MATEC Web of Conferences*. EDP Sciences, 20 Feb. 2019. Vol. 266, 05008. 1-7.
  34. Zamroni, M. (2020) Mengenal Prinsip Olah Sampah 3R (Reduce-Reuse-Recycle)–Tunas Hijau.
  35. Zhang, P., Li, N., Jiang, Z., Fang, D. and Anumba, C.J. (2019), An Agent-Based Modelling Approach for Understanding the Effect of Worker-Management Interactions on construction Workers' Safety-Related Behaviours, *Automation in Construction*, 97, 29-43