Original Article

Analytical Study of Generation, Composition, And Potential For Waste Recycling

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ABSTRACT

Background: *Waste is still a serious problem globally. Accumulated and poorly managed waste becomes a reservoir for disease vector animals in the environment. Sources of waste include home activities, offices, schools, campuses, industry, and other public places*

Methods: *This research was conducted using a survey, which took samples from several research locations and used observation sheets as a data collection tool. In this research, measurements and recording were carried out to calculate the generation and composition of waste in the campus environment.*

Results: *The research results describe the generation and composition of waste at one of the survey locations, Unja Sports Hall. The survey, conducted for five days, yielded results that included the average waste generation per day being 2.5 L and most food waste. The average dry waste generation is 5.3827 L consisting of 6.84% paper, 73.44% plastic, 2.15% badminton cocks and 17.58% styrofoam. The waste with the most significant recycling potential is dry, namely 76%, including 8.87% paper, 66.27% plastic, and 0.41% cans. Apart from that, wet waste also has the potential to be recycled as compost, namely 24.58%, consisting of 17.08% food waste and 7.77% yard waste. Based on organic and inorganic waste, organic waste has a recycling potential of 24.58%, and inorganic waste has a recycling potential of 66.27%.*

Conclusion: *Organic waste that can be recycled consists of food and yard waste, and inorganic waste consists of plastic, paper, and cans. This waste recycling process will produce a craft that has selling value. Before carrying out the recycling process, a waste sorting process is carried out according to specific criteria.*

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Introduction

Cases of disease in the community cannot be separated from the waste that accumulates in random places or storage locations without processing. This condition of garbage piling up without processing triggers

the arrival of various types of bacteria, viruses, and parasites, making the location of the garbage pile a reservoir for these disease vectors. (Dewanti et al., 2020). Globally, waste is a factor that influences climate and weather change. According to World Bank data, in 2016, the world's population produced 2.01 billion tonnes of waste, which is predicted to continue to increase to 2.59 billion tonnes in 2030, then 3.4 billion tonnes in 2050.

Currently, Indonesia is one of the world's largest waste-producing countries when viewed from its large population. The National Waste Management Information System released data on national waste generation in 2022, namely 51 thousand tons per day and 18.8 million tons per year, with composition and percentage based on waste sources including households 43.3%, offices 6%, traditional markets 24.1%, business centers 8.6%, public facilities 5.7%, areas 10.6%, and others 1.7% (SIPSN KemenLHK, 2022c). In 2022, Jambi City will have an area of 205.38 Km2 with a population based on data from the 2020 Population Census of 612,100 people (BPS Jambi City, 2022). Waste generation in Jambi City in 2022 is 437.50 tons per day and 159.7 thousand tons per year, with waste composition based on waste type including food waste 16.11%, wood or scrap 23.84%, paper 7.38% %, plastic 44.07%, metal 0.89%, fabric 0.57%, rubber or leather 1.23%, glass 0.3%, and others 5.61% (SIPSN KemenLHK, 2022b). If we look at the source of waste, households, markets, and public facilities are the most significant contributors to waste in Jambi City at 51.3%, 18.7%, and 6.27%, respectively, followed by other sources of waste, namely offices. , commerce, regional, and others (SIPSN KemenLHK, 2022a).

Several studies also concerned with problems in the campus environment, such as Faisya at one of the universities in Palembang, know that waste management in the campus environment also does not have a comprehensive management strategy (Faisya & Ainy, 2014). Likewise, research by Ika at a university in Yogyakarta showed that policies already exist, but their implementation is still technically tricky (Ardiati & Gati, 2021). Initial survey results show that the total number of maintenance facility officers on the Unja campus is 120, and they work 8 hours daily. There are three three-wheeled vehicles and four pick-up trucks available. Monitoring and evaluation are carried out daily by the person responsible for supervising the performance of facility care officers. There are rubbish bins available in every building and TPS at several locations. However, there is no implementation of 3R management, and there are no regulations in the Unja Campus environment as a derivative of Law Number 18 of 2008, passed down to Jambi City Regional Regulation Number 5 of 2020 (Jambi City Government, 2020).

Methods

This type of research is quantitative. Survey techniques involve taking samples from a population and using observation sheets as the primary data collection

tool. The locations for sampling waste generation were 12 points spread across 4 Jambi University campus areas. The tools used include digital crane scales (capacity 40 kg), a waste sample weighing box (20 x 20 x 100cm), a wooden ruler (100cm), an observation sheet, calculating and writing tools, gloves, mask, trash bag, and camera—measurement and calculation procedures according to SNI 19-3964-1994.

Results

Table 1. Generation and Composition of Waste in the Supporting Facilities Building at the Porkes GOR Building

No	Facilities	Composition of Waste	Tuesday			Wednesday			Thursday			Friday			Monday		
			l	m3	%	l	m3	%	l	m3	%	l	m3	%	l	m3	%
1	Supporting Facilities Building (1) GOR Building	a. Wet Waste															
		Food Waste	2,5	0,004	100,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%
		Yard Garbage (Leaves and the like)	0	0	0,00%	0	0	0,00%	0,987	0,0172	100,00%	0	0	0,00%	1,11	0,0148	100,00%
		Kayu	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%
		Total Wet Waste	2,5	0,004	100,00%	0	0	0,00%	0,987	0,0172	100,00%	0	0	0,00%	1,11	0,0148	100,00%
		b. Dry Waste															
		Paper	0,715	0,034	34,14%	0,425	0,022	51,40%	0,25	0,014	14,89%	0,566	0,014	6,84%	0,063	0,01	36,76%
		Plastic	3,75	0,0516	51,81%	0,265	0,0208	48,60%	2,37	0,08	85,11%	4,227	0,1504	73,44%	0,43	0,0172	63,24%
		Textile	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%
		Cards	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%
		Glass	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%
		Logam	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%
		Iron	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%
		Why badminton	0	0	0,00%	0	0	0,00%	0	0	0,00%	0,0237	0,0044	2,15%	0	0	0,00%
		Sterofoam	0,315	0,014	14,06%	0	0	0,00%	0	0	0,00%	0,566	0,036	17,58%	0	0	0,00%
		Total Dry Waste	4,78	0,0996	100,00	0,69	0,0428	100,00%	2,62	0,094	100,00%	5,3827	0,2048	100,00%	0,493	0,0272	100,00%

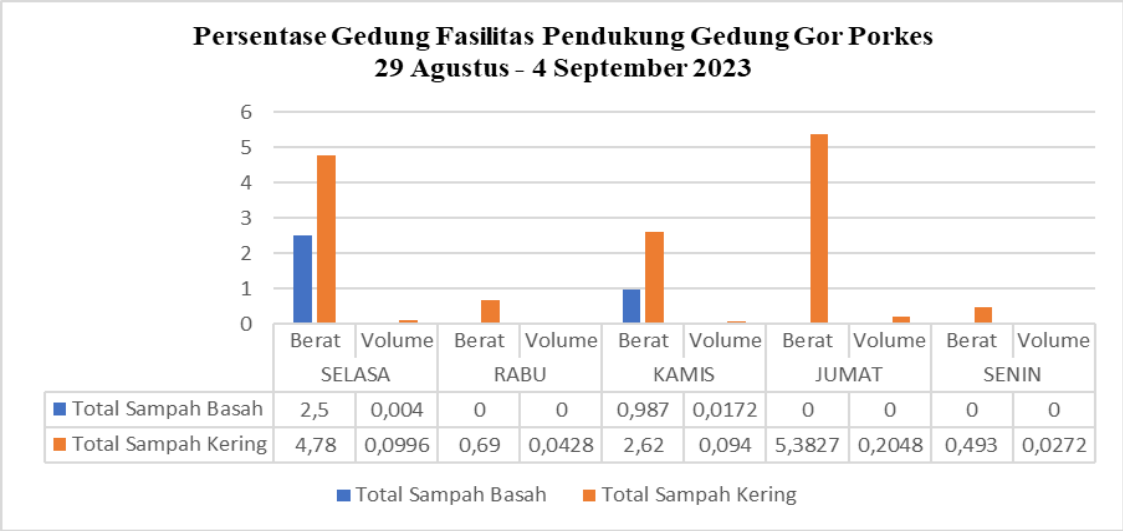

Figure 1. Percentage of Waste Generation and Composition in the Supporting Facilities of the UNJA Porkes GOR Building

Based on the recapitulation table of waste generation and composition in the Supporting Facilities Building for the Health Center Building, it is known that during the five days of research, the maximum generation of wet waste was found on Tuesday, namely 2.5 L, consisting of 100% food waste.

For dry waste in the five days of research, it was found that the maximum waste generation on Friday was 5.3827 L consisting of 6.84% paper, 73.44% plastic, 2.15% badminton shuttlecocks and 17.58% styrofoam. Meanwhile, the minimum generation of dry waste was found on Monday at 0.493 L, consisting of 36.76% paper and 63.24% plastic.

Table 2 Generation and Composition of Waste in the UPT Library Supporting Facilities Building

No	Facilities	Composition of Waste	Tuesday			Wednesday			Thursday			Friday			Monday		
			l	m3	%	l	m3	%	l	m3	%	l	m3	%	l	m3	%
2	Supporting Facilities Building (2) Library Building	a. Wet Waste															
		Food Waste	0	0	0,00%	0,875	0,00468	10,76%	0	0	0,00%	0	0	0,00%	0	0	0,00%
		Yard Garbage (Leaves and the like)	0	0	0,00%	5,445	0,0388	89,24%	0	0	0,00%	0	0	0,00%	0	0	0,00%
		Kayu	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%
		Total Wet Waste	0	0	0,00%	6,32	0,04348	100,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%
		b. Dry Waste															
		Paper	0,64	0,0308	49,04%	0,87	0,0192	39,02%	0,455	0,01	21,74%	0,328	0,006	13,64%	0	0	0,00%
		Plastic	2,595	0,032	50,96%	3,215	0,03	60,98%	3,605	0,036	78,26%	1,4775	0,038	86,36%	1,27	0,0188	100,00%

	Textile	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%	
	Cards	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%	
	Glass	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%	
	Logam	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%	
	Iron	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%	
	Kaleng	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%	0	0	0,00%	
	Total Dry Waste	3,235	0,0628	100,00%	4,085	0,0492	100,00%	4,06	0,046	100,00%	1,8055	0,044	100,00%	1,27	0,0188	100,00%	

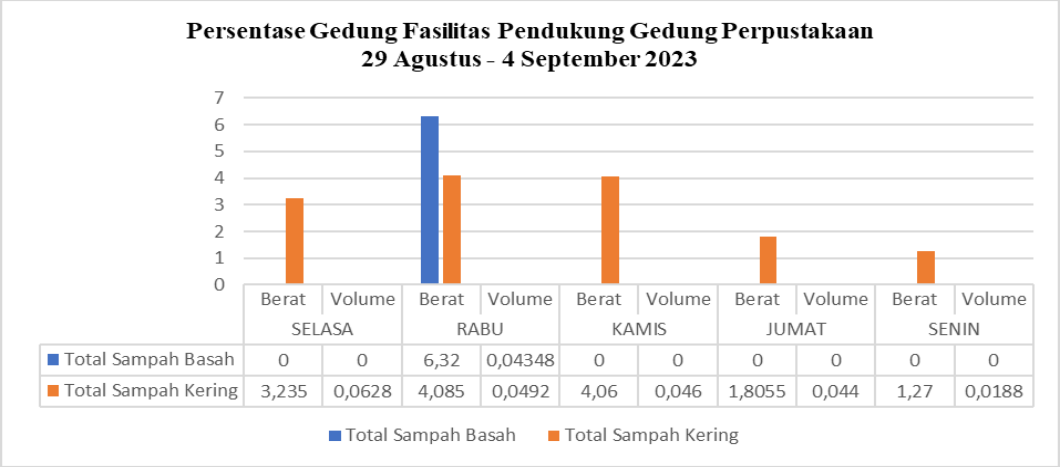

Figure 2. Percentage of Waste Generation and Composition in the Library UPT Supporting Facilities Building

Based on the recapitulation table of waste generation and composition in the Supporting Facilities Building for the Gor Health Building, it is known that during the five days of research, the generation of wet waste was only found on Wednesday, namely 6.3 L, consisting of 10.76% food waste and 89.24% solid waste. Page. For dry waste on the five days of research, it was found that the maximum waste generation on Wednesday was 4,085 L, consisting of 39.02% paper and 60.98% plastic. Meanwhile, the minimum generation of dry waste was found on Monday at 1.27 L, composed of 100% plastic.

Table 3 Rectorate Building and LPTIK

No	Facilities	Composition of Waste	Tuesday			Wednesday			Thursday			Friday			Monday		
			l	m3	%	l	m3	%	l	m3	%	l	m3	%	l	m3	%
1	Rectorate Office Building (1)	a. Wet Waste															
		Food Waste	3.175	44	16.66	0.745	120	42.86	0.985	80	100	0.965	100	100	1.375	140	100.00 %
		Yard Garbage (Dedauan and the like)	2.55	220	83.33	0.385	160	57.14	0	0	0	0	0	0	0	0	0.00%

No	Facilities	Composition of Waste	Tuesday			Wednesday			Thursday			Friday			Monday		
			l	m3	%	l	m3	%	l	m3	%	l	m3	%	l	m3	%
		Kayu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%
		Total Wet Waste	5.725	264	100	1.13	280	100	0.985	80	100	0.965	100	100	1.375	140	100.00 %
		b. Dry Waste															
		Paper	2.205	184	13.89	0.645	216	45	1.145	200	33.33	1.085	200	27.03	5.135	240	37.50 %
		Plastic	6.08	740	55.89	0.985	264	55	2.31	400	66.67	6.8	540	72.97	2.025	400	62.50 %
		Textile	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%
		Cards	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%
		Glass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%
		Logam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%
		Iron	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%
		Kaleng	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%
		Styrofoam	0.425	400	30.21	0	0	0	0	0	0	0	0	0	0	0	0.00%
		Others	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%
		Total Dry Waste	8.71	1324	100	1.63	480	100	3.455	600	100	7.885	740	100	7.16	640	100.00 %
2	LPTIK Office Building	a. Wet Waste															
		Food Waste	2.745	40	100	2.845	120	100	1.005	40	100	2.535	88	100	3.785	240	75.00 %
		Yard Garbage (Dedauan and the like)	0	0	0	0	0	0	0	0	0	0	0	0	0.515	80	25.00 %
		Kayu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%
		Total Wet Waste	2.745	40	100	2.845	120	100	1.005	40	100	2.535	88	100	4.3	320	100.00 %
		b. Dry Waste															
		Paper	5.64	628	51.14	1.875	284	41.52	0.705	140	21.88	0.515	312	54.55	0.475	400	28.99 %
		Plastic	5.2	600	48.86	2.445	400	58.48	3.19	500	78.13	1.435	260	45.45	5.175	980	71.01 %
		Textile	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%
		Cards	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%
		Glass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%
		Logam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%
		Iron	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%
		Kaleng	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%
		Others	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%
		Total Dry Waste	10.84	1228	10	.33	684	100	3.895	640	100	1.95	572	100	5.65	1,380	100.00 %

Rectorate Building:

- Wet food waste

The most significant amount of wet food waste generated is on Monday, and the least is on Tuesday.

- Leaf litter

Leaf litter is found on Tuesdays and Wednesdays

- Dry waste;
  - Paper waste: The most significant amount of paper waste generated is on Mondays, and the least amount is on Tuesdays
  - Plastic waste: The most plastic waste generated is on Tuesdays and Fridays, the least is on Wednesdays
  - Styrofoam trash: Styrofoam trash was found on Tuesday

LPTIK Building

- Wet food waste

For wet food waste generation, the most significant amount is on Mondays, and the least is on Tuesdays and Thursdays

- Leaf litter

The leaf litter was found on Monday

- Dry waste
  - Paper waste: The highest amount of paper waste is on Tuesday, and the least is on Thursday
  - Plastic waste: The most plastic waste is generated on Mondays and the least on Fridays.

Table 5. Rectorate Building and LPTIK Dry Waste

Part	Monday		Tuesday		Wednesday		Thursday		Friday	
	L	M3	L	M3	L	M3	L	M3	L	M3
Rectorate Building	8,71	1324	1,63	480	3,455	600	7,885	740	7,16	640
LPTIK Building	10,84	1228	4,33	684	3,895	640	1,95	572	5,65	1380
TOTAL	19,55	2552	5,96	1164	7,35	1240	9,835	1312	12,81	2020
Overall total					55,505					
Overall total (m3)					8288					

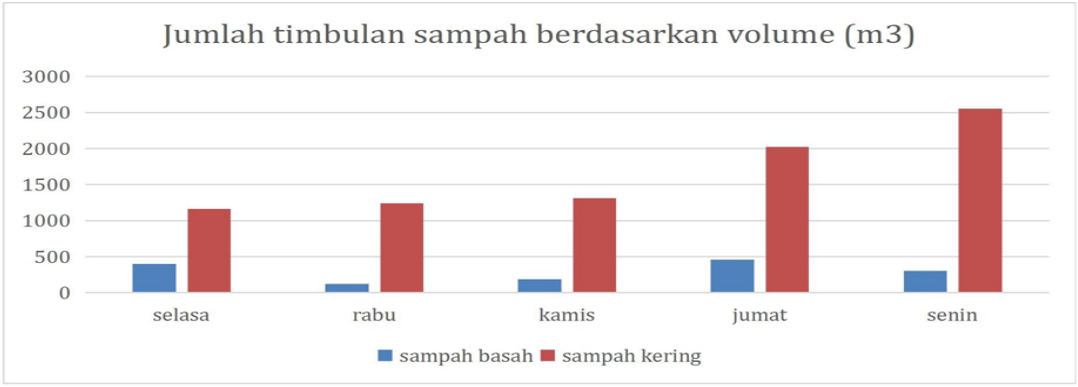

Figure 3. Amount of waste generated by volume (m3)

The graph shows that the most waste generated is in the dry waste category, and the most dry waste is found on Mondays, while the most wet waste is found on Fridays.

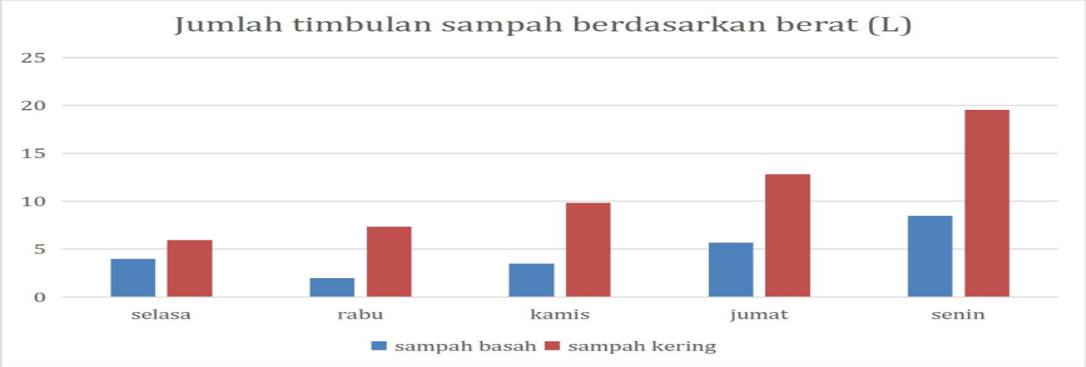

Figure 4. Amount of waste generation based on weight (L)

From the graph, it is known that the highest amount of waste generated is in the dry waste category, and the highest amount of dry waste is found on Mondays, while the most wet waste is found on Mondays.

Waste recycling is the process of changing used or waste materials into new materials that can be reused. Recycling aims to reduce the waste that ultimately ends up in final landfills (TPA), save natural resources, reduce pollution, and protect the environment (Rasyid and Hasibuan). Recycling potential is the ability that exists in waste components that can be developed for waste processing processes that produce new products. Types of waste that can be recycled are paper, plastic, glass, non-ferrous metals, ferrous metals, wood waste, yard waste, food waste, construction and renovation waste, used oil, used tires, batteries, and household batteries.

Based on the research results, it was found that several types of materials can be recycled, along with examples of the resulting recycled products, namely as follows:

Table 6. Types of materials that can be recycled at GOR Porkes and UPT UNJA Library

Gor and Library	
Types of Materials Recycled Material Type	Recycled Products
Plastic • Bottle • Plastic bag	Crackle bags, plant pots, pencil cases, and shopping bags.
Paper • HVS Paper • Writing Paper	Computer paper, writing paper and art paper

Table 7. Types of materials that can be recycled in the IKM Administration and Lecture Building and UNJA Pondok Meja Campus Canteen

Administration and lecture building of IKM and canteen of UNJA Pondok Meja campus	
Types of Materials Recycled	Recycled Products
Plastic • Bottle • Plastic bag	Crackle bags, plant pots, pencil cases, and shopping bags.
Paper • HVS Paper • Written paper	Computer paper, writing paper and art paper
Tin	Lampshades, vases, spoon and fork holders

Table 7. Materials that can be used in making compost

Place	**Materials used for making compost**
Gor and Library	• Food waste • Dedaunan
Administration and lecture building of IKM and canteen of UNJA Pondok Meja campus	• Dedaunan • Food waste

Table 8. Recapitulation of Waste Recycling Potential on the Pondok Meja Campus

It	Category		Waste Components	Potential of Facility Waste Recycling									
				Office		Perkuliahan		Supporting Facilities		Canteen		Places of Worship	
				l	%	l	%	l	%	l	%	l	%
1	Recyclable	Wet Garbage	Food Waste	0	0	1,09	96,9	3,357	0	12,198	100	0	0
			Yard Garbage	0	0	0,035	3,1	7,542	0	0	0	0	0
			Total Wet Waste	0	0	1,125	100	10,88	0	12,198	100	0	0
		Dry Waste	Paper Waste	0	0	4,334	29,33	4,312	0	0	0	0	0
			Plastic Waste	1,2616	78	10,405	70,42	23,20	0	29,72	100	0	0
			Glass Waste	0	0	0	0	0	0	0	0	0	0
			Iron and Metal Waste	0	0	0	0	0	0	0	0	0	0
			Canned Waste	0,365	22	0,035	0,25	0	0	0	0	0	0
			Total Dry Waste	1,6266	100	14,774	100	27,51	0	29,72	100	0	0
2	Not recyclable	Wet Garbage	Food Waste	0	0	0	0	0	0	0	0	0	0
			Yard Garbage	0	0	0	0	0	0	0	0	0	0
			Total Wet Waste	0	0	0	0	0	0	0	0	0	0
		Dry Waste	Paper Waste	0	0	0	0	0	0	2,178	100	0	0
			Plastic Waste	0	0	0	0	0	0	0	0	0	0
			Glass Waste	0	0	0	0	0	0	0	0	0	0
			Iron and Metal Waste	0	0	0	0	0	0	0	0	0	0
			Canned Waste	0	0	0	0	0	0	0	0	0	0
			Total Dry Waste	0	0	0	0	0	0	2,178	100	0	0

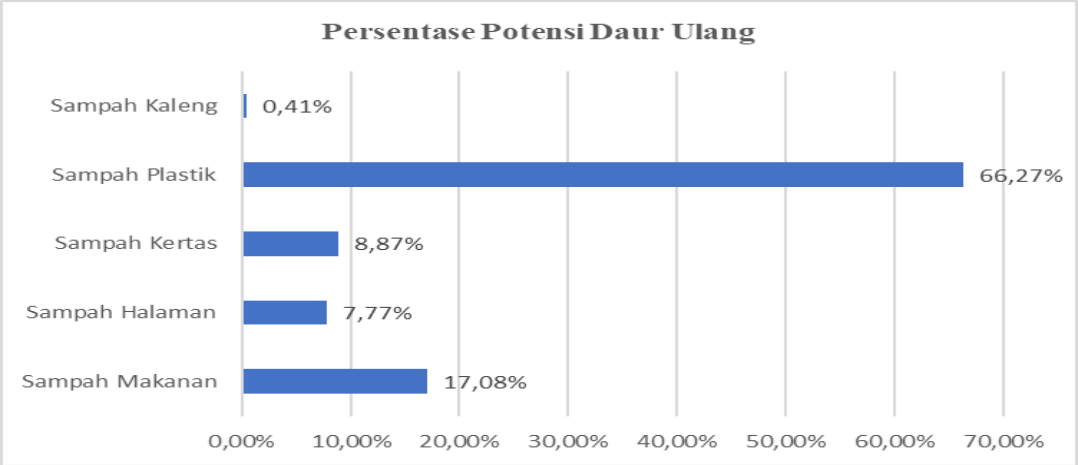

Figure 5. Percentage of Recycling Potential

Discussion

The waste with the most significant recycling potential is dry, namely 76%, including 8.87% paper, 66.27% plastic, and 0.41% cans. Apart from that, wet waste also has the potential to be recycled as compost, namely 24.58%, consisting of 17.08% food waste and 7.77% yard waste. Based on organic and inorganic waste, organic waste has a recycling potential of 24.58%, and inorganic waste has a recycling potential of 66.27%. Organic waste that can be recycled consists of food and yard waste, and inorganic waste consists of plastic, paper, and cans. This waste recycling process will produce a craft that has selling value. Before the recycling process, a process of sorting what kind of waste is carried out and how it will create a handicraft product.

The following are examples of waste recycling that can be done:

Ecopaving is a paving block formed from sand and plastic waste, whether HDPE, PET, PP, or other types. The use of this type of plastic in making eco-paving has been tested in several studies, and so far, none has had a compressive strength that exceeds that of plastic materials such as HDPE and LDPE9.

Recycling waste paper is the right solution to tackle the problem of paper waste. From recycled paper, you can make handicrafts using creative people's hands. Products made from recycled paper are widely used to decorate homes, stationery, office equipment, etc.

The potential for waste recycling can be seen from several characteristics of organic and inorganic waste, and from research that has been carried out, it was found that the most common waste found is wet food waste, dry paper, and plastic waste. Wet waste or food scraps are the most commonly found for potential waste recycling in the FKIK campus area. For recycling potential, what can be done to recycle waste is to make compost using the Takakura method.

I am making Compost using the Takakura Method. Tools/materials needed to make Takakura baskets: husks, liquid microorganisms, compost, organic waste, plastic baskets with lids, sewing needles, nylon thread, nets, scissors, cardboard

paper, thermometer, stocking cloth, sprayer, plastic tub, PDAM water and spoon of cement/chop. Takakura method of composting:

Provide a plastic basket with holes on both sides. Using a basket for dirty clothes that already have holes in them is more practical. You can also use a paint bucket with holes evenly drilled around it with a nail. This hole is significant so the wind can freely come in and out. The inside of the basket is lined with cardboard. The goal is to prevent rubbish from spilling The bottom is covered with husk, which is wrapped in gauze so that it does not mix with rubbish. On top of the husk, pile compost until at least half the height of the basket or starter. Cover again with a husk pad and black cloth, then with a plastic basket lid. When putting it in the trash, open the basket lid and remove the fabric and the top husk pad. The first waste is mixed with the compost using a shovel, and the basket is closed. When closed, the composting process is running. And so on, when adding trash, do the same thing. For example, if one group contains seven people with a basket 40 cm x 38 cm x 27 cm high, the basket will only be complete after about two months (Kurniati, 2013).

For the potential for waste recycling in the Jambi University campus area (Unja Mendalo), dry waste such as paper and plastic is often found. Plastic waste is usually used as packaging for materials or goods. Plastic is also used for household furniture, such as buckets, plates, and glasses. The advantage of plastic items is that they are durable and do not rust. The extensive use of plastic items can impact the production of waste items that are difficult to decompose, even though plastic waste requires quite a long time to decompose naturally in the soil. One effort that can be made is processing plastic waste to be recycled into other items. For example, plastic buckets can be recycled into similar products or made into different materials, such as plastic spoons, trash cans, or flower pots. Plastic from used snacks or detergent soap can be recycled into valuable items such as bags and wallets (Diana et al., 2017).

Other products that can be made from plastic waste are laptop carrying bags, shopping bags, sandals, or umbrellas. Used drink bottles can also be used to make children's toys, so processing used bottles makes the school environment more beautiful because used bottles that have been wasted are modified into more valuable objects. Meanwhile, drinking straw waste can be made into flower decorations, ashtrays, flower pots, photo frames, tablecloths, or wall decorations. Paper waste can be recycled either directly or indirectly. This means that the paper is made into crafts or other valuable items. Meanwhile, indirectly, this means that the paper can be melted first into pulp paper, then various crafts are made. Many types of paper recycling include decorative boxes, book covers, photo frames, and pencil cases.

Conclusion

Research results show that waste generation averages 5 to 10 L per day in each building on the Jambi University campus. The composition varies, including organic and inorganic waste. Potential recycling that can be carried out includes composting organic waste and converting inorganic waste into goods with selling value, such as eco vaping and processed recycled paper.

Authors Contributions

The author carries out tasks from data collection, data analysis, and discussions to making manuscripts.

Conflicts of Interest

There is no conflict of interest

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