



Evidence-based non-residential waste analysis to support 3R strategies and food recovery hierarchy: a case study in Solok Selatan

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Article info	Abstract
<p>Article History: Received: 02 February 2026, Revised: 01 March 2026, Available Online: 31 March 2026</p> <p>Keywords: Food Recovery Hierarchy, Composition, Non-Residential Waste, Generation, 3R Concept</p> <p>©2026 Bioeksperimen. This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 (CC-BY-NC) International (https://creativecommons.org/licenses/by-nc/4.0/).</p>	<p>The amount of waste generation that increases without being accompanied by good waste management will cause pollution and decrease the aesthetic value of the environment. Non-residential waste originating from non-residential activities is also one of the contributors to waste entering the landfill. This study aims to analyze non-residential waste generation and composition as an evidence-based reference for each source in implementing the 3R concept and the Food Recovery Hierarchy (FRH). The number of sampling sets was determined at a minimum of 10% of each type of facility following SNI 19-3964-1994. Sampling was carried out on eight consecutive days with 14 sampling points in Area 1, 14 in Area 2, and 11 in Area 3. The total non-residential waste generation was 46.79 m³/day (9.49 tons/day). Organic waste dominated the composition, accounting for 35–37% as food waste, followed by plastic (24–29%) and paper (14–20%). The high proportion of biodegradable and recyclable materials indicates significant potential for composting, recycling, and food recovery strategies at the source level. Implementing source-level 3R and FRH approaches could substantially reduce landfill dependency and extend landfill lifespan. This study addresses a knowledge gap by linking source-level non-residential waste characterization with the practical implementation of the 3R concept and the Food Recovery Hierarchy. This study provides quantitative evidence to guide localized waste minimization strategies in non-residential sectors.</p>

Introduction

Global solid waste generation continues to increase due to urbanization, economic growth, and population expansion, and is projected to reach 3.40 billion tonnes by 2050 (Kaza et al., 2018). Developing countries face significant challenges in managing this growth, as waste systems are often dominated by collection and disposal rather than reduction and resource recovery (Minghua et al., 2009; Olukanni et al., 2014). If the government fails to address the waste issue, it will disrupt more complex public services such as healthcare and transportation (Ishtiaq et al., 2018).

Waste problems can arise from various sources, including non-residential sources. Non-residential waste originates from non-residential areas such as commercial, institutional, and other waste (Tchobanoglous et al., 1993). Non-residential waste has a composition that is not much different from



domestic waste, where food waste is the most significant component (Raharjo & Geovani, 2015; Fauzi et al., 2022a). So that this food waste has the potential to be composted at the source scale because food waste has suitable characteristics for composting (Dewilda et al., 2022; Fauzi et al., 2023; Fauzi et al., 2022b). Only 40% of the waste goes to the landfill, 35% is collected and burned, 7.5% is stockpiled manually by the community, 1.6% is used in compost, and the rest discharges into rivers and drainage canals (Damahuri & Padi, 2016).

If there is no ability and willingness from the community to manage waste problems, waste can become a severe problem. Improper waste management will become a source of disease and can damage the aesthetics of the environment (Upadhyay et al., 2012; Kumar et al., 2017; Ferronato et al., 2018). Physical, chemical, and biological processes can also cause waste to disintegrate into smaller sizes, known as secondary microplastics (Fauzi et al., 2024; Moharir et al., 2019; Avio et al., 2017). These microplastics can cause a series of disturbances in living things (Cole et al., 2015; Gardon et al., 2018; Lee et al., 2013; Liu et al., 2020).

Solok Selatan District continues to apply conventional waste management practices, including open burning and uncontrolled disposal. The Environmental Health Risk Assessment (EHRA) report indicates that approximately 77.4% of waste is burned and 11% is disposed of into water bodies. These practices reflect limited source-level waste reduction efforts and insufficient data to support evidence-based planning. To date, no comprehensive study has quantified non-residential waste generation and composition in Solok Selatan District.

Alternative waste management needs to be designed to deal with waste problems. The principles of alternative waste management include making waste minimization a top priority, sorting the discarded waste for optimally composted or recycled, and each facility must redesign its products to facilitate recycling each product. Waste management starts from the source to the final processing site. If people's awareness of managing waste is at the source, it will affect the environmental impacts (Ding et al., 2021; Huang et al., 2020). Therefore, it is necessary to analyze the generation and composition of non-residential waste in Solok Selatan District as a reference for implementing the 3R concept and the Food Recovery Hierarchy at solid waste sources so that it can reduce waste generation that goes to landfills.

Materials and methods

This study was conducted in Solok Selatan District (01°17'13" - 01°46'45" SL and 100°53'24"-101°26'27" EL) from May to July 2025. The research focused on determining the generation unit, total generation, and composition of non-residential solid waste.

1. Primary Data Collection

Primary data on waste generation and composition were collected directly at the research site. Sampling was conducted for eight consecutive days in accordance with SNI 19-3964-1994 guidelines for municipal solid waste measurement and characterization. This standard provides technical guidelines for sampling duration, measurement procedures, and waste component classification. In this study, SNI was applied specifically for determining sampling methods, waste weighing procedures, and categorization into organic and inorganic fractions. The regulation does not prescribe waste processing methods but serves as a standardized framework for waste quantification and classification.

For one full day within the sampling period, waste from each sampling point was collected using plastic bags and transported to a designated measurement area. At the designated area, the weight and volume of the waste were measured. Subsequently, the waste was manually sorted into its respective components as part of the composition analysis procedure.

2. Secondary Data Collection

Secondary data collection in the form of the number of existing facilities in Solok Selatan District was obtained from data from the Central Statistics Agency (BPS) and distributing questionnaires. The data is needed to determine the number of sampling points. Solok Selatan District is divided into three areas to facilitate research and planning. Figure 1, shows the distribution of the sampling locations in Area 1, which comprises the sub-districts of Sungai Pagu, Pauh Duo, and Koto Parik Gadang Diateh. Area 2 includes Sangir District, and Area 3 includes Sangir Jujuan, Sangir Batang Hari, and Sangir Balai Janggo Districts.

The determination of sampling points in this study follows the Indonesian National Standard (SNI) 19-3964-1994 with a minimum of 10% of each facility. The number of sampling facilities in each area and the number of sampling points are described in [Table 1](#), [Table 2](#), and [Table 3](#).

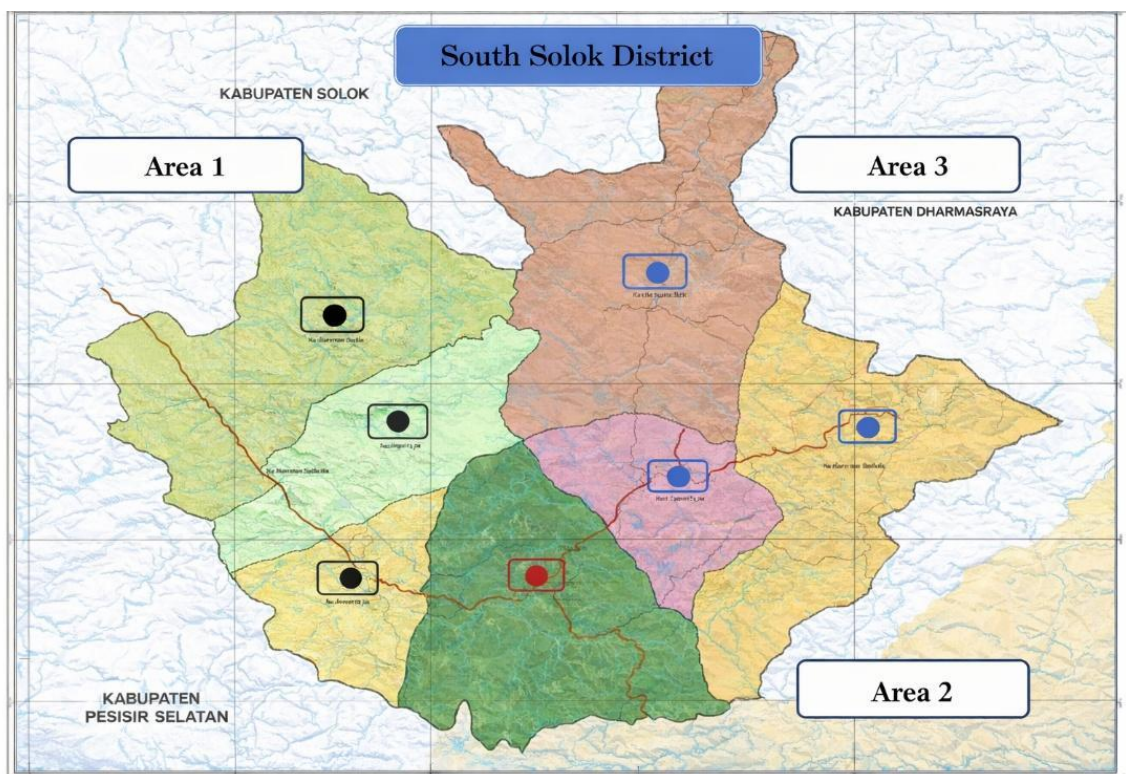


Figure 1. Distribution of Sampling Locations
 Source: SIKN Pemkab South Solok, 2022

Table 1. Number of Facility and Samples in Area 1

No	Facility	Amount	Sample
1	Market	2	2
2	Shopping Complex	14	2
3	School	19	2
4	Offices Complex	18	2
5	Healthcare Unit	17	2
6	Restaurant	19	2
7	Hotel	9	1
8	Tourist Attraction	10	1
9	Street	0	0
Total		108	14

Source: BPS of Solok Selatan District, 2020

Table 2. Number of Facility and Samples in Area 2

No	Facility	Amount	Sample
1	Market	2	2
2	Shopping Complex	16	2
3	School	17	2
4	Offices Complex	20	2
5	Healthcare Unit	9	2
6	Restaurant	22	2
7	Hotel	6	1
8	Street	1	1
Total		93	14

Source: BPS of Solok Selatan District, 2020

**Table 3. Number of Facility and Samples in Area 3**

No	Facility	Amount	Sample
1	Market	2	2
2	Shopping Complex	17	2
3	School	16	2
4	Offices Complex	15	2
5	Healthcare Unit	11	1
6	Restaurant	8	2
7	Tourist Attraction	0	0
8	Street	0	0
Total		69	11

Source: BPS of Solok Selatan District, 2020

3. Data Analysis

Waste characterization followed the Indonesian National Standard SNI 19-3964-1994, which provides technical procedures for measuring waste generation and classifying waste components. The waste was categorized into two primary fractions: organic and inorganic waste, as well as wet and dry components.

Organic components included food waste, paper, plastic, wood, rubber, and fabric, while inorganic components consisted of ferrous metals, non-ferrous metals, and glass. Wet waste components included food waste and wood waste, whereas dry waste consisted of ferrous metals, non-ferrous metals, paper, plastic, rubber, fabric, and glass.

Data analysis was performed using descriptive statistical methods. Waste generation rates were calculated in kilograms per unit per day (kg/unit/day) and kilograms per capita per day (kg/capita/day) following SNI 19-3964-1994 standards. The percentage composition of each waste category was determined by dividing the weight of each component by the total waste weight and multiplying by 100%.

The results were presented in tabular and graphical forms to illustrate variations in waste generation across different non-residential facilities. The analysis aimed to identify dominant waste components and evaluate the potential implementation of source-based 3R and Food Recovery Hierarchy (FRH) strategies.

Results and discussion

The analysis of non-residential waste generation was conducted to compare generation rates across three administrative areas in Solok Selatan District. Waste generation was evaluated based on both volume (L/unit/day) and weight (kg/unit/day) to provide a comprehensive understanding of waste characteristics. The comparison among areas aims to identify dominant waste-producing sectors and assess spatial variations in non-residential waste generation patterns.

1. Waste Generation

a) Non-residential Waste Generation Unit in Area 1

The non-residential waste generation units in Area 1 are presented in [Table 4](#). The largest generation in terms of volume was recorded in the hospital sector (3.548 L/unit/day), while in terms of weight, the market sector showed the highest value (0.917 kg/unit/day). The lowest generation rate was observed in the tourist attraction sector, both in volume (0.019 L/unit/day) and weight (0.002 kg/unit/day). The average waste generation unit in Area 1 was 1.617 L/unit/day in volume and 0.307 kg/unit/day in weight.

b) Non-residential Waste Generation Unit in Area 2

For non-residential waste generation units in Area 2 are shown in [Table 5](#). The largest generation unit in terms of volume is the hospital, 4.869 L/unit/day, in terms of weight, the market is 0.856 kg/unit/day. The smallest generation unit in volume units is a school at 0.058 L/unit/day, while in weight units is a road at 0.015 kg/unit/day. The average non-residential waste generation unit for Area 2 is 1.728 L/o/day in volume units and 0.326 kg/o/day in weight units.

c) Non-residential Waste Generation Unit in Area 3

Non-residential waste generation units in Area 3 are illustrated in [Table 6](#). The largest unit of waste generation in volume unit is found in the market with 4.000 L/unit/day, while the weight unit is in the



healthcare sector with 0.676 kg/unit/day. The smallest result in the volume unit is at the school sector with 0.095 L/unit/day, while in weight unit is also found at the school with 0.022 kg/unit/day. The average non-residential waste generation unit in Area 3 is 2.038 L/o/day in volume units and 0.319 kg/o/day in weight units.

d) Total Generation of Non-residential Waste

Based on data on non-residential waste generation in Solok Selatan District, the total waste per day is determined by multiplying the waste generation by the number of existing facilities in Solok Selatan District. The amount of non-residential waste generation per day in South Solok District is shown in [Table 7](#), [Table 8](#), and [Table 9](#). Based on [Table 7](#), [Table 8](#), and [Table 9](#), the highest non-residentials waste is found in Area 1, with 19.19 m³/day, and the least is in Area 2, with 11.84 m³/day. This is because Area 1 has more facilities than Area 2.

The total non-residential solid waste generated in Solok Selatan District reaches 9.49 tonnes/day in weight units or approximately 46.79 m³/day in volume units. This quantity reflects the significant contribution of non-residential activities, such as commercial establishments, public facilities, offices, markets, and institutional sectors, to the overall waste stream in the district. Waste generation data is vital for determining how to manage waste in an area ([Miezah et al., 2015](#)), as it provides a fundamental basis for planning waste collection systems, transportation capacity, treatment technologies, and final disposal requirements. Accurate measurement of waste generation also enables local authorities to estimate infrastructure needs, allocate resources efficiently, and design appropriate waste reduction strategies.

Table 4. Non-residential waste generation units in Area 1

Source	Unit	Waste Generation Unit (l/Unit/d)	Average of Waste Generation Unit (l/Unit/d)	Waste Generation Unit (kg/Unit/d)	Average of Waste Generation Unit (kg/Unit/d)
Healthcare Unit	Bed	3.548		0.552	
Office	Employee	0.411		0.120	
School	Student	0.030		0.008	
Restaurant	Employee	2.715	1.617	0.337	0.307
Restaurant	Seat	1.376		0.307	
Market	Stall	2.723		0.917	
Hotel	Bed	2.112		0.210	
Tourist Attraction	Area	0.019		0.002	

Table 5. Non-residential waste generation units in Area 2

Source	Unit	Waste Generation Unit (l/Unit/d)	Average of Waste Generation Unit (l/Unit/d)	Waste Generation Unit (kg/Unit/d)	Average of Waste Generation Unit (kg/Unit/d)
Healthcare Unit	Bed	2.393		0.399	
Office	Employee	0.513		0.143	
School	Student	0.058		0.120	
Store	Employee	3.082	1.728	0.646	0.326
Restaurant	Seat	1.682		0.307	
Market	Stall	4.869		0.856	
Hotel	Bed	1.109		0.123	
Street	Length	0.116		0.015	

**Table 6. Non-residential waste generation units in Area 3**

Source	Unit	Waste Generation Unit (l/Unit/d)	Average of Waste Generation Unit (l/Unit/d)	Waste Generation Unit (kg/Unit/d)	Average of Waste Generation Unit (kg/Unit/d)
Healthcare Unit	Bed	3.643		0.676	
Office	Employee	0.600		0.157	
School	Student	0.095	2.038	0.022	0.319
Store	Employee	2.119		0.355	
Restaurant	Seat	1.773		0.180	
Market	Stall	4.000		0.524	

Table 7. Total of Non-residential Waste Generation Area 1

Source	Total of Facilities	Total Unit	Unit	Waste Generation(/d)	Total (m ³ /d)	Waste Generation (kg/d)	Total (Ton/d)
Healthcare Unit	17	233	Bed	826.66		128.60	
Office	10	340	Employee	139.62		40.97	
School	56	21,987	Student	654.46		180.64	
Store	1,599	4,797	Employee	13,023.20		1,617.27	
Restaurant	19	703	Seat	967.67	19.19	215.87	3.31
Market	15	1,200	Stall	3,267.86		1,100.0	
Hotel	9	90	Bed	190.04		18.86	
Tourist Attraction	1	6,300	Area	120.95		12.60	

Table 8. Total of Non-residential Waste Generation Area 2

Source	Total of Facilities	Total Unit	Unit	Waste Generation(l/d)	Total (m ³ /d)	Waste Generation (kg/d)	Total (Ton/d)
Healthcare Unit	9	83	Bed	198.61		33.12	
Office	27	810	Employee	415.67		115.83	
School	76	1,1940	Student	694.62		1,432.80	
Store	796	2,388	Employee	7,359.85	11,84	1,542.65	3.67
Restaurant	22	880	Seat	1,480.14		269.78	
Market	2	280	Stall	1,363.39		239.58	
Hotel	6	84	Bed	93.18		10.36	
Street	1	500	Length	232.00		30.86	

Table 9. Total of Non-residential Waste Generation Area 3

Source	Total of Facilities	Total Unit	Unit	Waste Generation(l/d)	Total (m ³ /d)	Waste Generation (kg/d)	Total (Ton/d)
Healthcare Unit	12	84	Bed	306.00		56.78	
Office	8	240	Employee	143.88		37.71	
School	124	11,517	Student	1,098.03	15.76	255.26	2.51
Store	1,357	4,071	Employee	8,625.54		1,445.42	
Restaurant	8	264	Seat	468.01		47.52	
Market	16	1,280	Stall	5,120.00		670.17	

2. Composition of Non-residential Waste

Based on the research conducted, the composition of Areas 1, 2, and 3 can be seen in [Table 10](#), [Table 11](#), and [Table 12](#). HU = Healthcare Unit, OF = Office, SH = School, ST = Store, RS = Restaurant, MR = Market, HT = Hotel, TA = Tourist Attraction, and X = Average (in%). Based on [Table 10](#), [Table 11](#), and [Table 12](#), the most extensive composition of food waste comes from restaurants and markets, and this is because restaurants and markets have community activities that produce food waste. Likewise, the least

amount of food waste comes from stores. Non-residential waste has a similar composition when compared to domestic waste.

This similarity indicates that waste generation is largely influenced by human consumption patterns and activity intensity in each sector. The dominance of food waste in restaurants and markets reflects the high level of food preparation, processing, and distribution activities in these facilities. In contrast, stores generally generate less organic waste because their activities focus more on product sales rather than food processing. Understanding these differences is important for determining appropriate waste handling methods and improving the effectiveness of waste management planning. Such information can also support the implementation of waste reduction programs, particularly in managing organic waste through recycling or composting initiatives.

Table 10. Composition of Non-residential Waste in Area 1 (%)

Component	HU	OF	SH	ST	RS	MR	HT	TA	X
Organic									
Food Waste	41.557	15.259	17.638	8.936	81.696	71.563	22.079	31.210	36.242
Paper	11.517	45.726	18.468	19.536	0.978	7.198	10.306	5.326	14.882
Plastic	19.548	19.151	43.278	50.593	5.213	13.978	22.385	25.317	24.933
Textile	0.000	0.000	0.000	0.000	0.000	0.543	1.504	2.408	0.557
Rubber	3.783	0.000	0.000	0.000	0.000	0.000	1.742	2.286	0.976
Yard Waste	2.088	6.658	11.021	0.000	0.000	0.000	14.568	8.653	5.374
Wood	0.000	2.795	2.067	0.000	0.000	0.543	1.401	2.692	1.187
Total Organic	78.493	89.590	92.473	79.065	87.886	93.826	73.985	77.892	84.151
Inorganic									
Glass	4.433	1.215	0.000	9.366	0.354	0.481	5.086	3.739	3.084
Ferrous Metals	0.000	0.000	0.000	0.000	0.000	0.000	1.253	0.000	0.157
Non-Ferrous Metals	0.000	0.000	0.000	7.759	0.000	1.760	3.686	2.909	2.014
Other	17.074	9.195	7.527	3.810	11.759	3.933	15.990	15.460	10.594
Total Inorganic	21.507	10.410	7.527	20.935	12.114	6.174	26.015	22.108	15.849
Total	100	100	100	100	100	100	100	100	100

Table 11. Composition of Non-residential Waste in Area 2 (%)

Component	HU	OF	SH	ST	RS	MR	HT	TA	X
Organic									
Food Waste	44.289	10.930	13.697	8.992	75.826	81.138	55.358	10.263	37.562
Paper	17.778	63.177	11.897	20.882	2.185	10.539	17.301	14.530	19.786
Plastic	20.875	24.099	73.832	49.289	12.567	6.808	21.573	24.468	29.189
Textile	0.433	0.000	0.000	0.430	0.000	0.758	0.000	1.122	0.343
Rubber	0.000	0.000	0.000	0.729	0.000	0.000	0.000	1.786	0.314
Yard Waste	2.540	0.000	0.575	0.571	0.000	0.000	0.000	30.456	4.268
Wood	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total Organic	85.914	98.206	100.00	80.893	90.578	99.242	94.231	82.625	91.461
Inorganic									
Glass	0.952	0.000	0.000	6.430	4.264	0.000	1.348	3.078	2.009
Ferrous Metals	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.857	0.357
Non-Ferrous Metals	0.000	0.000	0.000	5.996	1.812	0.758	0.000	2.727	1.412
Other	13.134	1.794	0.000	6.681	3.346	0.000	4.420	8.712	4.761
Total Inorganic	14.086	1.794	0.000	19.107	9.422	0.758	5.769	17.375	8.539
Total	100	100	100	100	100	100	100	100	100

Table 12. Composition of Non-residential Waste in Area 3 (%)

Component	HU	OF	SH	ST	RS	MR	HT
Organic							
Food Waste	36.423	8.300	21.039	5.244	64.946	76.667	35.436
Paper	10.296	56.975	24.667	26.870	5.210	4.524	21.424
Plastic	16.522	9.014	34.687	47.640	14.463	7.381	21.618
Textile	3.571	0.193	0.323	0.794	0.279	0.833	0.999
Rubber	0.000	0.000	0.219	1.588	0.201	0.000	0.335



Component	HU	OF	SH	ST	RS	MR	HT
Yard Waste	14.687	15.892	10.363	0.661	1.693	0.000	7.216
Wood	0.000	0.901	0.627	0.000	0.000	0.000	0.255
Total Organic	81.500	91.275	91.924	82.797	86.792	89.405	87.282
Inorganic							
Glass	1.607	1.320	1.383	5.346	3.459	2.857	2.662
Ferrous Metals	1.099	0.000	0.000	0.000	0.000	0.000	0.183
Non-Ferrous Metals	0.893	1.818	0.809	1.589	4.874	3.214	2.200
Other	14.901	5.587	5.884	10.268	4.874	4.524	7.673
Total Inorganic	18.500	8.725	8.076	17.203	13.208	10.595	12.718
Total	100	100	100	100	100	100	100

3. The Understanding of Non-residential Parties on the 3R Concept

The survey was carried out by distributing questionnaires prepared and then filled in by the facility owner or a representative according to the questions contained in the questionnaire. There were 14 questionnaires distributed in Areas 1 and 2 and 11 in Area 3. The results of the questionnaire are illustrated in [Figure 2](#). Based on [Figure 2](#), the facilities need help to understand what the 3R concept is. In each area, more facility owners know about the Reuse than the Reduce and the Recycle of the 3R concept. Some facilities reuse purchased items; for example, paint cans are used as flower pots and water containers. Based on the questionnaire results, the facilities owner who understood the Reduce concept in 3R began to replace tissues with handkerchiefs and avoid using plastic things, such as stopping using plastic straws and replacing plastic packaging with plates that could be used many times. Moreover, in the implementation of the Recycle concept of the 3R, some facility owners reported composting organic waste and selling recyclable materials to collectors; however, the overall implementation remains limited.

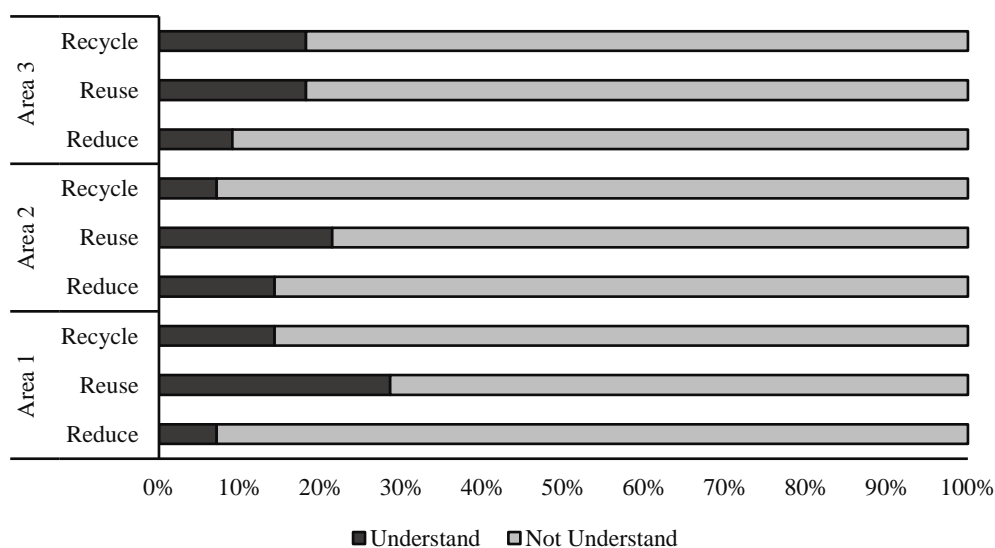


Figure 2. Questionnaire's result

4. The 3R Concept and Food Recovery Hierarchy (FRH)

The concept appropriate at the source scale is the 3R concept, which consists of 3 principles, namely:

a) Reduce /R1

According to [Nasir et al. \(2015\)](#), a waste audit will help the food industry identify the types of waste created and make improvements. The reduction or reduction principle aims to reduce waste, particularly waste generated during the manufacturing process. Waste must be eliminated by replacing raw resources or commodities with high production capacity. This step is taken to save costs and can be a strategy to minimize expenses in purchasing materials. Reduction efforts that can be done such as:

1). Choose products with recyclable packaging; 2). Avoid using and purchasing products that generate large

amounts of waste; 3). Using refillable products; 4). Cutting back on the use of throwaway materials.

b) Reuse/ R2

The notion of waste reuse involves the direct utilization of created garbage. An example of a reuse application pertains to food waste, which can serve as animal feed; however, it must exclude meat, coffee grounds, and high salt content, as these can be detrimental to animals (USEPA, 2014). Examples of food waste as animal feed are tofu waste (Handayanta, 2007; Kusumaningtyas et al., 2020; Yakin et al., 2019), waste from processing chips (Purnamasari et al., 2018), waste from noodles (Widodo et al., 2010; Karmee, 2016), waste from bread (Setiyoningsih et al., 2022).

c) Recycle/R3

The principle of waste recycling is to process un reusable waste to have a usable value again, such as the recycling process in composting and anaerobic digesters (Aziz et al., 2023). Coffee waste is an example of organic waste that can be processed biologically. Coffee waste can produce alternative fuels like briquettes (Khusna & Susanto, 2015). Coffee grounds waste can be used with other materials to create interior items (Limantara et al., 2019). In addition, tofu waste can also be used to make flour (Putri et al., 2018). Another example is soybean dregs reprocessed into renegeing (Yustina, 2011) and cassava waste made into chips, flour, and liquid sugar with High nutritional content, including protein, fat, calcium, and carbs (Ulya, 2018). In addition, food waste can also be processed into compost because it has biological and chemical characteristics that are suitable for biological processing (Dewilda et al., 2023; Aziz et al., 2025).

In addition to the 3R concept, the FRH concept is also appropriate for non-residential parties in managing food waste generated at the source. This strategy is an outgrowth of the more sophisticated 3R concept. This approach to waste management employs an inverted pyramid-shaped hierarchy. Each level of the hierarchy takes a different approach to food waste management. The campaign regarding the FRH is reducing waste at the source, donating food to people in need, feeding livestock from leftovers, using energy for industry from anaerobic biogas processes, composting, and landfills. For more details, Figure 3 describes how to process food waste using the FRH idea.

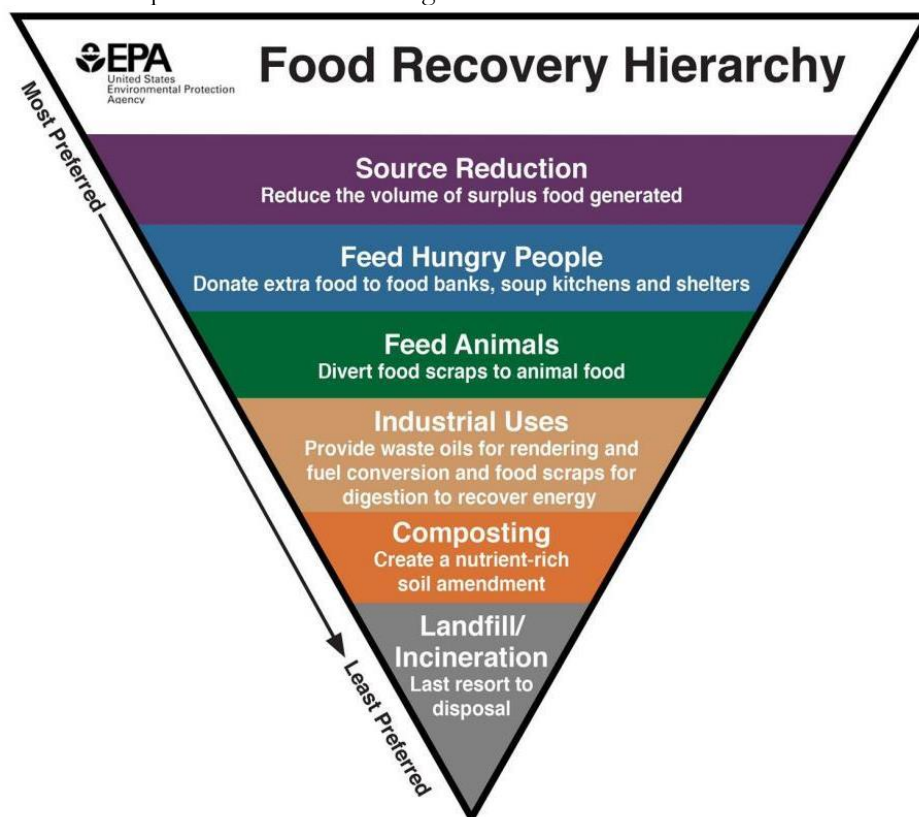


Figure 3. Food Waste Processing based on the FRH

Source: USEPA, 2016



5. The 3R Concept and Implementation at the Source

Social and economic factors are indicators of successful waste management in developed countries ([Lee-Geiler & Kutting, 2021](#); [Razzaq et al., 2021](#)). Communities with environmental awareness and sufficient government financing in building infrastructure produce waste management systems that are relatively advanced compared to developing countries ([Malinauskaite et al., 2017](#); [Wang et al., 2020](#)). In contrast, developing countries, where the lack of finance and the habits of the people who lack environmental awareness cause difficulties for the government in developing waste management systems ([Al-Khatib et al., 2007](#); [Azevedo et al., 2019](#); [Tsai et al., 2007](#)).

The step for solving this issue is to increase community knowledge about environmental awareness. The factors that influence the individual, such as subjective standards, attitudes, environmental consciousness, and behavioral influence over judgments about trash management, will support the reduction of waste at the source (Tekler et al., 2019). The 3R concept needs to be instilled in the community to be implemented. It will help the government handle the waste problem from a financial perspective in infrastructure development, where waste is firstly managed at a source scale with the 3R concept so the unmanaged residues can be taken to the landfill. Because if the minimum funding of waste management, the government still handles all the waste problems, it will cause difficulties in dealing with them. Furthermore, if the government fails to address waste issues, it will disrupt more complicated services such as health and transportation.

The total generation of non-residential waste in Solok Selatan District reaches 9.49 tons/day (46.79 m³/day). Waste composition analysis shows that organic waste constitutes the largest fraction across all areas, particularly food waste generated by restaurants, markets, and service facilities. This indicates strong technical potential for implementing reduction and recovery strategies at the source level. Food waste is the highest composition of waste generated at the source by 35% - 37%. The high composition of food waste produced is because, in their daily activities, the population produces much waste in the form of food waste, vegetable waste, and fruit waste. If each facility processes this food waste, it will reduce the waste that goes to the landfill. Besides that, controlling food consumption also effectively reduces food waste from each source.

The resulting waste contains recyclable materials such as paper, plastic, glass, and metal and compostable materials such as leftovers, vegetables, and fruit peels ([Sharholy et al., 2008](#)). The composition of plastic waste from the habit of using plastic products in daily life can be replaced with containers that are more eco-friendly and usable for long periods. Furthermore, the tissue waste can be replaced with a handkerchief. However, food wrapping paper, tissue paper, art paper, food wrappers, and carbon paper are types of waste that do not have the potential to be recycled, and reducing these types of waste is in line with reducing greenhouse gas emissions ([Islam, 2018](#)). In addition, it is necessary to put forward the concept of Zero Waste Cities to reduce waste from the source ([Song et al., 2015](#)). Overall, the findings demonstrate that Solok Selatan District possesses high material recovery potential based on its waste composition profile. However, limited awareness, insufficient segregation practices, and lack of institutional enforcement constrain practical implementation. Therefore, strengthening policy instruments and community-based waste education programs is essential to bridge the gap between potential and practice. The waste can be sorted and sold to collectors. Apart from helping the government in waste management, it also generates income for society at the source.

Conclusion

This study confirms that non-residential activities in Solok Selatan District generate a substantial amount of waste, reaching 9.49 tons/day (46.79 m³/day), thereby contributing significantly to landfill burden. Waste composition analysis indicates that organic waste, particularly food waste from markets and restaurants, constitutes the dominant fraction, while recyclable materials such as plastic, paper, glass, and metal remain present in considerable proportions.

The findings reveal a clear opportunity for improving source-level waste management. Although the waste stream demonstrates high recovery potential, limited segregation practices and insufficient application of the 3R concept constrain effective material utilization. Differences in waste generation among Areas 1, 2, and 3 further indicate that facility density and activity type strongly influence waste intensity.

Therefore, applying the 3R concept and the Food Recovery Hierarchy at each source is necessary to reduce waste going to landfills. It is necessary to replace materials that can be used repeatedly, such as



tissues with handkerchiefs and disposable containers. The waste composition, which consists of various components such as plastic, paper, glass, metal, and others, can also be sorted at the source to be sold to collectors. Meanwhile, the composition of leftover food is reprocessed into consumable new products and can also be used as animal feed. Implementing the 3R concept and Food Recovery Hierarchy will minimize the waste that goes to the landfill so that it can extend the landfill's life.

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