JOURNAL OF CULTURAL ANALYSIS AND SOCIAL CHANGE

Journal of Cultural Analysis and Social Change,
2025, 10(3), 949-962
ISSN: 2589-1316

Waste Management and Circular Economy Approach in Sinjai Regency

T.R. Fahsul Falah[1*], Muhammad Hatta Jamil[2], Eymal B Demmalino[1], Ariady Arsal[3], Yenita Sandra Sari[4]

[1]*Enviromental Science Study Program, Graduate School, Hasanuddin University, Makassar, 90254, Indonesia; tr.ffalah@gmail.com*
[2]*Department of Socio-economics of Agriculture, Faculty of Agriculture, Hasanuddin University, Makassar, 90254, Indonesia.*
[3]*Agribusiness Study Program, Graduate School, Hasanuddin University, Makassar, 90254, Indonesia.*
[4]*Natural Science Education, Universitas Islam An Nur Lampung, South Lampung, 35365, Indonesia.*

*__Corresponding Author:__ tr.ffalah@gmail.com

Citation: Falah, T. F., Jamil, M. H., Demmalino, E. B., Arsal, A., & Sari, Y. S. (2025). Waste Management and Circular Economy Approach in Sinjai Regency. *Journal of Cultural Analysis and Social Change*, *10*(3), 949–962. https://doi.org/10.64753/jcasc.v10i3.2532

Published: November 28, 2025

ABSTRACT

Waste management creates new opportunities for sustainable economic growth. The success of circular economy-based waste management will greatly depend on regulatory support, local innovation, and consistent community education, making it a challenge in Sinjai Regency to determine how to manage waste using a circular economy approach. This study aims to analyse circular economy-based waste management methods that can be applied in Sinjai Regency as an alternative. The method used in this research is qualitative descriptive with primary data sources from waste bank managers, observations, and interviews, and secondary data based on waste management documents by Waste Banks in Sinjai Regency. The results show the application of the 3R strategy (Reduce, Reuse, Recycle) in community-level waste management. Efforts to minimise environmental impact include saving waste, empowering communities to reduce waste generation, and utilising waste for recycling. Adding value to waste management is very important as it provides various benefits that can support environmental sustainability, the economy, and society. Environmental sustainability, through added-value analysis, directs waste management to reduce carbon emissions through recycling or reusing materials. Added-value analysis helps identify processes that contribute maximally to waste management.

Keywords: Household Waste, Waste Generation, Reduce, Reuse, Recycle.

INTRODUCTION

Population growth and changes in consumption patterns have led to an increase in the volume, types, and characteristics of increasingly diverse waste. However, waste management has not yet aligned with environmentally conscious methods and techniques, resulting in negative impacts on public health and the environment [1]. Waste management involves activities such as collection, transportation, processing, recycling, or disposal of waste materials. Most people view waste as useless leftovers, failing to recognise its potential as a valuable resource [2]. Community waste management still focuses on the end-of-life approach, namely collection, transportation, and final disposal. Consequently, waste has become a national issue requiring comprehensive and integrated management from source to disposal to provide economic benefits, promote public health, ensure environmental safety, and change community behaviour [3][4]. The establishment of waste banks marks the beginning of fostering collective awareness among communities to start sorting, recycling, and utilising waste because it holds significant added value (monetary worth), making environmentally conscious waste management a new cultural practice in Indonesia [5].

The potential for waste generation increased from 39,319.84 tonnes in 2022 to 39,939.61 tonnes in 2023. The amount of waste reduction in 2022 was 9,719.50 tonnes, which decreased to 9,051.60 tonnes in 2023. Furthermore,

the amount of waste handled in 2022 was 26,453.00 tonnes, which also declined to 22,026.00 tonnes in 2023. Based on this data, managed waste in 2022 amounted to 36,172.50 tonnes (92%), decreasing to 31,077.60 tonnes (77.81%) in 2023, while unmanaged waste in 2022 was 3,147.35 tonnes (8%), showing an increase to 8,862.01 tonnes (22.19%) in 2023. The interpretation of the above data indicates a rise in poorly managed waste, making it the responsibility of Sinjai Regency's Environmental and Forestry Service to implement waste management that can add economic value to increase Regional Original Income (PAD). The form of added economic value at Waste Banks is the financial value added to each type of waste saved by the community, as different types of waste have varying prices [6]. The Waste Bank then calculates the added value of the waste type into a savings book, allowing the community to experience the economic benefits of collected waste [7][8]. Waste Banks do more than just manage waste; they also turn recycling innovations into handicrafts [9]. To determine the added value in these crafts, the higher the complexity of craft creation, creativity, and quality, the higher the selling price [10].

Several stages of waste management that add value are carried out by Sinjai Regency's Environmental and Forestry Service and community groups: the first stage is sorting at TPS3R and Waste Banks, followed by household waste collection using containers and door-to-door systems. The container system involves placing 13 containers in strategic locations. Once full, these containers are transported by 10 six-wheeled vehicles with an average of 3–4 trips per day to the landfill (TPA). The door-to-door system uses three-wheeled vehicles that collect waste from the environment and place it into containers, with an average of 4-5 trips per unit per day. Additionally, the Clean City Movement (Gesit) is conducted at specific points involving stakeholders (government agencies, universities, vertical institutions, and the community) and 192 sanitation task force members. For future waste management development in Sinjai Regency, a Feasibility Study Document for Bongki Lengkese Landfill has been prepared, and through Sinjai Regency's Public Works Service, funds have been allocated for an appraisal team to clear land. The percentage of managed waste up to September 2023 is 44.88% (17,308.38 tonnes) out of the target of 99% or 38,567.69 tonnes, including waste handling amounting to 11,271.59 tonnes and waste reduction of 6,036.79 tonnes. Waste management coverage extends beyond urban areas to rural areas, particularly in markets within sub-district capitals. For the 2023 Waste Management Budget, Sinjai Regency's waste management activities for 2023 were funded through Regional Original Income (DAU) amounting to Rp. 2,458,006,400 and had been realised up to 25 October 2023 at Rp. 2,393,759,900.00 or 97.39%.

In 2023, Sinjai Regency recorded approximately 70 tonnes of waste generated daily, with around 30–40% successfully managed through routine collection and transportation to Batu Belerang Landfill [11]. Although this figure has not met the national target of 70% effective waste management, an increasing trend is observed due to the growing number of active waste banks, recycling communities, and collaborations with schools and Islamic boarding schools in zero-waste programs. Beyond technical indicators, non-material achievements such as community participation, behavioural changes in waste sorting, and increased environmental awareness are crucial to the success of circular programs. Sinjai Regency has begun an educational approach by involving community leaders and environmental cadres. However, challenges like limited infrastructure and information gaps still require attention. This model not only demonstrates economic relationships between production and consumption units but also identifies systemic leakage points (waste leakage) that need reduction. With this approach, Sinjai Regency can map the circular economy ecosystem involving household players, transporters, processors, collectors, and end consumers. Utilising simple technologies such as biodigesters, plastic shredders, and digital applications for waste management can strengthen integrated input-output systems. Local governments are expected to act as facilitators that promote inter-player integration, expand market access, and provide results-based financing. Transforming the waste management system towards a circular economy in Sinjai Regency requires a holistic, data-driven, and participatory approach. By understanding waste density, evaluating indicator achievements, maximising added value, and building dynamic input-output models, Sinjai Regency can not only address waste issues but also create new sustainable economic opportunities. The success of circular economy-based waste management will greatly depend on regulatory support, local innovation, and consistent community education. Therefore, the research question is: How is waste managed using a circular economy approach in Sinjai Regency?

LITERATURE REVIEW

Concept of 3R Waste Management

Environmental science dictates that good waste management ensures waste does not become a breeding ground for disease or spread illness [12][13]. Other requirements include not polluting air, water, or soil; avoiding unpleasant odours (aesthetic concerns); preventing fires; and other factors. Waste management encompasses all activities involved in handling waste from generation to final disposal. Broadly, these activities include controlling waste generation, collection, transfer, transportation, processing, and final disposal. According to Article 1 of Law No. 18 of 2008 on Waste Management, waste management is a systematic, comprehensive, and continuous activity

that includes waste reduction and handling [14]. Waste reduction involves limiting waste generation, recycling, and utilising waste [15].

Waste management can be categorised into two types: local handling, where waste generators manage it themselves by burying it in their yards or other permissible methods, possible if the environment's carrying capacity is high, such as available land and low population density; and centralised management, where waste handling is coordinated to serve a specific area [16][17]. The concept of waste management applied at Waste Banks is based on the zero-waste approach [18], which involves an integrated system of urban waste processing technology at the community level aimed at minimising waste as much as possible. This concept aligns with what is mandated in Law No. 18 of 2008, which advocates for waste management through the Reduce, Reuse, and Recycle (3R) approach. Circular economy is a system that addresses global challenges such as climate change, biodiversity loss, high waste, and pollution through economic activities that minimise waste and pollution, maintain products and materials at their highest value, and regenerate nature [19][20]. The circular economy is an alternative to the traditional economy, where economic activities preserve resources for as long as possible, maintain their value during use, and reuse them to create new products at the end of their lifecycle [21][22]. Circular economy as a system aimed at maximising the product life cycle from resource selection, production, consumption, to disposal by promoting practices such as zero-waste design, reuse, repair, and sharing resources. Based on this, it is understood that the concept of a circular economy is an alternative to the linear economy [23][24]. The linear economy is a system of economic activities applied with the 'take-make-use-dispose' cycle, where resources are extracted from the earth (take), processed into products (make), consumed (use), and quickly discarded when they no longer have value (waste) [25][26].

The circular economy recognises the 'take-make-use-return' cycle, where resources are responsibly extracted (take), processed into products (make), used while maintaining their value (use), and at the end of their lifecycle, returned for processing into new products (return). The circular economy approach is known as the 5R principle, consisting of five elements: reduce, reuse, recycle, refurbish, and renew [27][28]. The circular economy can be applied in six product life cycle stages: raw materials (resources), product design, production, retail, consumption, and end-of-life [29]. All these stages aim to save resources from disposal and reintroduce them into production or consumption according to circular economy principles.

Collective Waste Management

A waste bank is a collective waste management system that encourages community participation [30]. This system collects, sorts, and channels economically valuable waste to the market so that the community can benefit economically from saving waste [31]. Waste deposited by customers must already be sorted. This requirement encourages communities to separate and group waste, for example, by material type: plastic, paper, glass, and metal. Thus, waste banks create a new culture of waste sorting. Therefore, the waste bank system can serve as a tool for social engineering, creating a better waste management system in the community. Law No. 18 of 2018 on Waste Management mentions three types of waste that must be managed: household waste, similar household waste, and specific waste. Based on their origin, solid waste can be categorised into two types: organic waste is produced from living materials that can be degraded by microbes or are biodegradable [32]. This waste can easily decompose through natural processes. Most household waste consists of organic materials, including kitchen waste, food leftovers, packaging (excluding paper, rubber, and plastic), flour, vegetables, fruit peels, leaves, and branches [33]. Additionally, traditional markets contribute significantly to organic waste, such as vegetable and fruit waste, among others; inorganic waste is produced from non-living materials, whether synthetic products or results of technological processing of mining materials [34]. Inorganic waste is divided into: metal waste and its products, plastic waste, paper waste, glass and ceramic waste, and detergent waste [35][36]. Most inorganic waste cannot be fully decomposed by nature or microorganisms (unbiodegradable) [37][38]. Some can only decompose over a long period. Examples of this type of household waste include plastic bottles, glass bottles, plastic bags, and cans [39].

Based on their form or shape, three types of waste or waste are known: liquid waste, solid waste, and gas waste. Examples of liquid waste include washing water, soapy water, used cooking oil, and others [40]. Examples of solid waste include snack packaging, used tyres, mineral water bottles, and others. Examples of gaseous waste include carbon dioxide (CO_2), carbon monoxide (CO), HCL, NO_2, SO_2, and others. Recycling all waste and returning it to the community economy or nature is a highly promising alternative for creating waste-free environments and improving community economies [41][42]. Recycling also reduces pressure on natural resources. Rather than continuously dealing with increasing waste volumes, minimising waste seems to be a top priority [43]. Waste management is based on the 3R principle [44]. Waste management also involves community participation. Waste is limited from its source, and at each handling stage, processes of sorting, reuse, and recycling are carried out until they have economic and ecological benefits [45].

RESEARCH METHODS

Location and time the research was conducted at Sinjai Regency's Environmental and Forestry Service. This study is field research using a qualitative descriptive method. The qualitative descriptive method is a research procedure that produces descriptive data in the form of words or spoken language from people and observable behaviour [46][47]. Data sources refer to how data is obtained. In this study, the researcher used primary and secondary data sources. Primary data is data obtained directly from the research object as the information source sought. In this study, primary data were obtained by observing field conditions based on observation results and interviewing Waste Bank managers. In this study, secondary data refers to data that researchers cannot obtain directly but that is obtained from other parties. Data collection was conducted through observational approaches to obtain primary data by directly observing the data object. In this study, the researcher focused on observing the waste bank's economic added-value management system. Interviews were then conducted with two parties: the interviewer who asked questions and the interviewee who provided answers to those questions. In this research, interviews were conducted by asking questions directed at Waste Bank managers and community members, or customers [48][49]. During the interview, the researcher used a structured approach, where the researcher prepared a series of questions in advance, and the informant was free to provide answers. Interviews were used to obtain information (data needed by the researcher) about waste banks to determine the economic added value of waste management. Documentation is a data collection technique directed at research subjects. Documents can include personal notes, private letters, diaries, work reports, cassette recordings, video recordings, and photos. Documentation was conducted using document instruments such as archives, waste bank profiles, organisational data, unit business reports, and photos or images during Waste Bank management activities, including photos of customers depositing waste and photos of Waste Bank managers creating waste crafts. This research was conducted at Sinjai Regency's Environmental and Forestry Service. The choice of this research location facilitated the researcher's access to data related to added value in waste management in Sinjai Regency. The first observation parameter for added value in waste management is waste management through the 3R approach.

The reduce approach involves minimising the use of materials or items we consume [50][51]. Added value, referred to as the Hayami method, illustrates the return for labour, capital, and management that can be expressed mathematically as follows:

Added Value = f {K, B, T, U, H, h, L}

Where:

K = Production capacity
B = Raw materials used
T = Labour used
U = Wage labour
H = Output price
h = Raw material price
L = Other input value (value of all sacrifices that occur during the treatment process to add value)

RESULTS AND DISCUSSION

Waste Management through Reduce, Reuse, and Recycle

The Waste Bank applies the 3R strategy in community-level waste management. The implementation of the Waste Bank program aims to minimise environmental impacts on communities. In addition to saving waste, the Waste Bank also empowers communities to reduce waste generation, utilise waste, and recycle it. According to Article 1, Paragraph 2 of Minister of State for the Environment Regulation No. 13 of 2012 on Guidelines for Implementing Reduce, Reuse, and Recycle through Waste Banks, a Waste Bank is a place for sorting and collecting recyclable and/or reusable waste that has economic value. The researcher conducted interviews with selected informants from the Waste Bank management team and community members who are customers of the Waste Bank in Sinjai Regency. The researcher interviewed AM as the manager of Samaturu Waste Bank, to ask about waste management in Sinjai Regency:

> "The Waste Bank has been operating for quite some time and has had a positive impact on the community in Sinjai Regency by reducing the volume of waste ending up at the landfill through recycling processes. Additionally, the Waste Bank provides economic benefits to the community through programs that exchange waste for money or goods". (Interview conducted on 21 October 2024)

The above interview indicates that the Waste Bank plays a crucial role in society by helping reduce the amount of waste disposed of at landfills through sorting and managing economically valuable waste such as plastic, paper, metal, and other recyclable materials. The existence of the Waste Bank encourages communities to be more aware of the importance of waste management. Education provided by the Waste Bank helps communities understand how to sort waste and its impact on the environment. The researcher then interviewed a community member who

is a customer of the Waste Bank in Sinjai Regency. The researcher asked about the role of the Waste Bank in managing waste, and the following is the result of the interview:

> "With the existence of this Waste Bank, I see it as a positive thing. This means there are business opportunities from the government where we, as community members, can participate in managing waste that adds value, including recycling processes, making us more creative in developing skills from the waste itself. In short, the Waste Bank can organise all collected waste, reduce waste, and environmental pollution. So, the waste we collect and sort can be sold at the Waste Bank, and from the sales proceeds, we receive money". (Interview conducted on 21 October 2024)

The interview results with the informant show that the Waste Bank serves as a platform for communities to collaborate in maintaining environmental cleanliness, thereby strengthening solidarity and community cooperation. The Waste Bank helps realise the government's sustainable waste management programs, such as reducing plastic waste and achieving national waste reduction targets. The existence of the Waste Bank raises community awareness about the importance of waste management. Waste that is usually considered useless can become a source of income through the Waste Bank. Communities can sell sorted waste and receive money in return. The Waste Bank creates business opportunities for waste management, recycling, and creative products based on waste. This also opens up job opportunities for individuals involved in Waste Bank operations and related industries.

In terms of objectives and targets in the strategic service plan (Renstra) of Sinjai Regency's Environmental and Forestry Service, efforts to protect and manage the environment include three targets: achieving a 75% waste handling percentage for household and similar household waste in 2022 and 74% in 2023; reducing household and similar household waste through 3R with targets of 22% in 2022 and 24% in 2023; and managing a waste volume target of 9,072 tonnes in 2022 and 8,618.4 tonnes in 2023, as shown in the table below:

Table 1. Waste-Related Service Objectives and Targets at Sinjai Regency's Environmental and Forestry Service.

Objective	Target	Performance Target	
		2022	2023
Increase efforts to protect and manage the environment	Percentage of household and similar household waste handled	75%	74%
	Percentage of household and similar household waste utilised through the 3R	22%	24%
	Volume of managed waste (tonnes)	9,072.0	8,618.4

Source: *Renstra of Sinjai Regency's Environmental and Forestry Service, 2024.*

Waste management planning in Sinjai Regency is based on Regional Regulation No. 10 of 2017 on Waste Management, which includes the 3R approach in the strategic plan of the environmental and forestry service and the creation of Standard Operating Procedures (SOP) for waste management implementation. Waste management with the 3R Program in Sinjai Regency involves four unit waste banks and one parent waste bank located at DLHK. Observation results show that the implementation of Waste Banks in Sinjai Regency has not yet increased community awareness in waste management with the 3R approach, as evidenced by the development of only three Waste Banks: Samaturu Waste Bank, Osim Waste Bank, and Cumi-cumi Waste Bank. Waste management through this waste bank system is expected to help the government address waste issues and improve community economies. Additionally, Sinjai Regency's Environmental and Forestry Service operates the Sinjai Bersatu Parent Waste Bank Mobile Unit to directly collect waste such as used plastic bottles, paper, newspapers, or used cardboard boxes. Supporting cleanliness facilities in this case include operational cleanliness vehicles at Sinjai Regency's Environmental and Forestry Service, which consist of 31 three-wheeled vehicles, 8 Amroll units, and 3 dump trucks. In terms of human resources for waste management in Sinjai Regency, the availability is sufficient, but regarding facilities and infrastructure, it is still very limited due to the many waste disposal facilities that are no longer usable, and from the availability of Waste Banks, one Parent Waste Bank has been formed, located in front of the Sinjai Regency Livestock Service Office. The achievement of indicators by Sinjai Regency's Environmental and Forestry Service in the 2023 performance report (LKJ) regarding the percentage of waste handled is 100.09% of the target, the percentage of waste utilised through 3R is 99.4% of the target, and the volume of waste generated.

Table 2. Achievement of Indicators by Sinjai Regency's Environmental and Forestry Service in 2023.

No	**Performance Indicator**	**Initial Condition**	**2023**		
			Target	**Realisation**	**Realisation (%)**

1	Waste handled	42.58%	75.00%	75.07%	100.09%
2	Waste utilised through 3R	7.29%	22.00%	21.90%	99.40%
3	Waste managed	13,395.80 tonnes	9,02.00 tonnes	29,446.01 tonnes	326.19%

Source: LKJ of Sinjai Regency's Environmental and Forestry Service, 2024

Based on Table 2, the supervision of Sinjai Regency's Environmental and Forestry Service involves several of its employees or sanitation task forces in waste processing, and the form of evaluation when reporting the volume of managed waste shows a monthly decrease. In actual practice, supervision regarding waste management through the 3R approach in Sinjai Regency is still not optimal, as it only involves field task forces. Suboptimal waste management poses significant challenges due to various factors such as low community awareness, inadequate infrastructure, and inconsistent regulation enforcement. Many community members still do not understand the importance of sorting and managing waste, leading them to dispose of waste indiscriminately. Most areas in Sinjai Regency lack an organised waste sorting system, causing organic, plastic, and metal waste to mix, making recycling difficult. More waste banks or recycling centres are needed, especially in rural or remote areas. Additionally, landfills using the open dumping method can contaminate soil and water.

Analysis of Added Value in Circular Economy Waste Management

The analysis of added value in waste management is an analysis with a sustainable approach based on the 3R principle that provides significant added value both economically, socially, and environmentally. Before conducting an added-value analysis, studies were conducted regarding household waste generation, waste density, waste composition, recovery factor, and sorting speed.

Waste Generation

A study of household waste generation was conducted based on sampling in the field for eight consecutive days. Household waste samples were collected from selected neighbourhoods, namely Balanipa Village with a population of 11,359 people, and in Sinjai Regency 2024, the population reached 267,540 people. The location determination was based on population density levels. Measurement results show that the average waste generation per person per day is 0.29 kg/person/day. The amount of waste generated by each individual varies due to habits or lifestyle. Waste generation data can be seen in Table 3.

Table 3. Household Waste Generation.

Day	Total Waste Weight (kg)	Samples (households)	Samples (people)	Waste Generation (kg/household/day)	Waste Generation (kg/person/day)
1	151.47	120	495	1.26	0.31
2	133.64	120	495	1.11	0.27
3	136.72	120	495	1.14	0.28
4	135.75	120	495	1.13	0.27
5	136.36	120	495	1.14	0.28
6	138.44	120	495	1.15	0.28
7	146.30	120	495	1.22	0.30
8	150.93	120	495	1.26	0.30
Average Waste Generation					0.29

Waste generation per person per day is used as a basis to determine the total household waste generated. The amount of waste per person per day is 0.29 kg/person/day. When converted into litres using the density value from this study (145.96 kg/m^3), it is 1.99 L/person/day. Waste generation in large urban settlements based on SNI 3242-2008 on Waste Management in Settlements is 3 L/person/day. From this data, it is known that household waste generation in Sinjai Regency is lower than in large urban settlements. Based on the average waste generation calculation, the total daily household waste can be calculated as follows:

Population in 2024 = 267,540 people
Waste Generation per Person = 0.29 kg/person/day
Total Waste Generation = Population × Waste Generation per Person
= 267,540 people × 0.29 kg/person/day
= 77,586.60 kg/day

Waste Density and Collective Waste Management

Household waste density measurement in Sinjai Regency was conducted for three days. The purpose of this household waste density measurement is to determine the volume of waste generated at the source and the volume of waste entering. Based on field sampling, it is known that not all 100 kg of waste can fit into a density box. This is due to the current diversity of household waste types, which have large volumes, such as bottles, plastic glasses, and other packaging leftovers. Household waste density in Sinjai Regency from analysis results ranges between 141.12 kg/m^3 – 151.94 kg/m^3, with an average household waste density of 145.96 kg/m^3. Household waste density measurement can be seen in Table 4.

Table 4. Household Waste Density

Sampling Day	Total Waste (kg)	Box Dimensions		Box Volume (m^3)	Waste Density (kg/m^3)
		Base Area (m^2)	Height (m)		
1	59.98	0.5	0.85	0.425	141.12
2	69.13	0.5	0.91	0.455	151.94
3	63.00	0.5	0.87	0.435	144.82
Average					145.96

Based on Table 4, the rate of waste generation in Sinjai Regency can be calculated as follows:

Total Waste Generation = 32,194.46 kg/day
Waste Density = 145.96 kg/m^3
Waste Generation Rate = total waste generation/ waste density
32,194.46 kg/day
= 32,194.46 kg/day / 145.96 kg/m^3
= 220.57 m^3/day

Waste Composition

An analysis of household waste composition was conducted to determine the types of waste in Sinjai Regency. The waste composition data were obtained from sampling over three days, with a total waste weight exceeding 100 kg. The sorted waste types include compostable waste, such as garden and food waste. Next, plastic waste is categorised into PET, HDPE, PVC, LDPE, PP, PS, and others. Paper waste includes newspaper, computer/HVS paper, mixed paper, duplex, magazines, and coloured paper. Other waste types are glass, fabric, rubber, wood, mixed metal, and others. Field calculations show that household waste composition in Sinjai Regency is dominated by food and vegetable waste as well as garden/park waste, accounting for 66.71%. Garden waste is largely generated from individual or sanitation officer street cleaning activities. The percentage of food waste is 59.35%, and garden waste is 7.36%. Household waste composition calculations can be seen in Table 5.

Table 5. Calculation of Household Waste Composition.

No	Waste Type	Waste Mass (kg)			Average (kg)	Percentage (%)
		1	2	3		
1	Food waste	76,89	77.19	86.95	80.34	59.35%
2	Garden waste	12.12	11.79	5.97	9.96	7.36%
3	Plastic waste				9.78	7.23%
	a) PET	2.98	4.01	1.17	2.72	2.01%
	b) HDPE	2.15	2.95	2.07	2.39	1.77%
	c) PVC	2.00	2.07	1.69	1.89	1.39%
	d) LDPE	0.56	1.69	0.92	1.06	0.78%
	e) PP	0.62	0.91	0.76	0.76	0.56%
	f) PS	0.55	0.74	0.85	0.71	0.53%
	g) Multilayer and Others	0.30	0.11	0.32	0.24	0.18%
4	Paper waste				5.87	4.34%
	a) Newspaper	0.81	0.54	0.10	0.48	0.35%
	b) Cardboard	3.87	2.72	3.96	3.52	2.60%
	c) Computer/HVS Paper	1.13	0.19	0.45	0.59	0.44%
	d) Mixed Paper, Duplex, Coloured Magazines	0.77	1.40	1.68	1.28	0.44%
5	Glass waste	6.44	6.39	0.7	4.57	3.37%
6	Fabric waste	4.05	6.94	7.37	6.12	4.52%
7	Rubber waste	1.59	1.20	1.88	1.56	1.15%
8	Wood waste	1.55	1.18	6.05	2.93	2.16%

9	Mixed metal waste	2.37	2.19	0.28	1.61	1.19%
10	Other waste	12.89	12.50	12.48	12.62	9.33%
Total		133.64	136.72	135.75	135.37	100.00%

Based on Table 5, it is shown that plastic waste is the second most dominant type of waste at 7.23%, followed by paper waste at 4.34%, fabric waste at 4.52%, glass waste at 3.37%, wood waste at 2.16%, rubber waste at 1.15%, mixed metal waste at 1.19%, and other waste at 9.33%.

Recovery Factor

The calculation of the Recovery Factor (RF) aims to determine the amount of waste that can be utilised and that cannot be utilised. This RF survey was conducted over three days, and the results were averaged to obtain the average RF value. The RF value is obtained from the total weight of sorted waste based on its composition, which is then further sorted into what can be utilised either as compost or for recycling/resale. The sorting results are then weighed again. The results of the RF for household waste in Sinjai Regency can be seen in Table 6.

Table 6. Recovery Factor for Household Waste in Sinjai Regency

Based on Table 6, it is known that the average total RF in Sinjai Regency is 42.68%, so the waste that should be disposed of at the landfill is 57.32%. This RF is the result of primary data collection and will be used as a reference for optimising waste management with the 3R approach.

No	**Waste Type**	**I**			**II**			**III**			**Average RF (%)**
		Weight (kg)	**Recovery (kg)**	**RF (%)**	**Weight (kg)**	**Recovery (kg)**	**RF (%)**	**Berat (kg)**	**Recovery (kg)**	**RF (%)**	
1	Food waste	76.89	35.18	45.75	77.19	38.84	50.32	86.95	42.21	48.55	48.21
2	Garden waste	12.12	4.32	35.65	11.79	5.04	42.77	5.97	2.84	47.51	41.98
3	Plastic waste	9.16	6.96	75.96	12.49	8.83	70.71	7.70	5.59	72.55	72.90
	a) PET	2.98	2.29	76.88	4.01	2.07	51.50	1.17	0.67	56.99	61.79
	b) HDPE	2.15	1.92	89.62	2.95	2.92	98.87	2.07	2.00	96.70	95.06
	c) PVC	2.00	1.96	98.41	2.07	1.96	94.81	1.60	1.55	97.39	96.87
	d) LDPE	0.56	0.43	75.79	1.69	1.17	69.19	0.92	0.81	87.26	77.41
	e) PP	0.62	0.35	56.10	0.91	0.71	78.53	0.76	0.55	72.76	69.13
	f) PS	0.55	0	0	0.74	0	0	0.85	0	0	0
	g) Multilayer and Others	0.30	0	0	0.11	0	0	0.32	0	0	0
4	Paper waste	6.58	4.21	64.05	4.84	3.15	65.11	6.20	3.99	64.34	64.42
	a) Newspaper	0.81	0.45	55.41	0.54	0.28	52.54	0.10	0.06	65.77	57.91
	b) Cardboard	3.87	2.20	56.71	2.72	1.49	54.87	3.96	2.22	55.87	55.82
	c) Computer/ HVS Paper	1.13	1.02	89.89	0.19	0.17	88.39	0.45	0.42	93.46	90,58
	d) Mixed Paper, Duplex, Coloured magazines	0.77	0.55	72.11	1.40	1.21	86.76	1.68	1.29	76.35	78.41
5	Glass waste	6.44	4.21	65.45	6.39	1.60	24.98	0.87	0.39	44.87	45.10
6	Fabric waste	4.05	0	0	6.94	0	0	7.37	0	0	0
7	Rubber waste	1.59	0.53	33.46	1.20	0.44	36.83	1.88	0.65	34.28	34.86
8	Wood waste	1.55	0	0	1.18	0	0	6.05	0	0	0
9	Mixed metal waste	2.37	1.93	81.41	2.19	1.77	80.70	0.28	0.25	88.78	83.63
10	Other waste	12.89	0	0	12.50	0	0	12.48	0	0	0
Total		133.64	57.34	42.91	136.72	59.68	43.65	135.75	55.91	41.18	42.68

Sorting speed

The calculation of sorting speed aims to determine how many kilograms of waste one person can sort in one hour. Sorting speed is needed to analyse whether existing labour is optimal in sorting waste and to calculate the number of required workers. This sorting speed survey was conducted over three days, and the results were averaged to obtain the average sorting rate.

Waste Weight = 133.64 kg
Number of Sorters = 2 people
Sorting Start Time = 10.05

Sorting End Time = 10.52 (47 minutes)
= Waste/ (Number of people x Sorting Duration)
= 133.64 kg/ (2peoplex0.78 hours
= 85.30 kg/person/hour
The results of household waste sorting speed in Sinjai Regency can be seen in Table 7.

Table 7. Household Waste Sorting Speed in Sinjai Regency.

No	Waste Weight (kg)	Number of Sorters (people)	Start Time	End Time	Duration (minutes)	Duration (hours)	Sorting Speed (kg/hour)
1	133.64	2	10:05	10:52	47	0.78	85.30
2	136.72		09:38	10:20	42	0.70	97.66
3	135.75		09:50	10:35	45	0.75	90.50
Total							91.15

The value-added analysis uses the Hayami method. This value-added analysis of 3R waste management calculates production capacity, raw materials used, labour, labour wages, output prices, raw material prices, and the value of other inputs. The results of these calculations are presented in Table 8.

Table 8. Added Value Analysis Using the Hayami Method for 3R Waste Management.

No	Variable	Formula	Waste Management Results		
			Plastic Waste	Organic	Paper
1	Production capacity	K	11	7	5
2	Raw materials	B	7	3	2
3	Labour input	T	4	1	1
4	Conversion factor	FK = K/B	1.60	2.33	2.50
5	Labour coefficient	KT = T/FK	2.55	0.40	0.40
6	Output price (Rp.)	H	611,000	280,000	200,000
7	Labour wages (Rp.)	U	14,500	7,142	6,000
8	Raw material price (Rp.)	H	70,000	30,000	18,000
9	Other input value (Rp.)	L	18,600	13,000	10,000
10	Output value (Rp.)	NO = FK × H	960,143	653,333	500,000
11	Added value (Rp.)	NT = NO – H – L	871,543	610,333	472,000

The added value in 3R waste management is sufficient to meet economic needs. Table 6 shows the processing of plastic waste with an input of 7 kg of raw materials and producing an output of 11 kg. The labour involved in management totals four people, resulting in a conversion factor of 1.6 and a labour coefficient of 2.55. The output product price is Rp. 611,000, with an average wage earned by workers of Rp. 14,500. The input raw material cost is Rp. 70,000, and other inputs used in plastic recycling amount to Rp. 18,600, producing an output value of Rp. 960,143. Thus, the added value obtained is Rp. 871,543 per production. Organic waste management uses 3 kg of raw materials and produces an output of 7 kg. The labour involved in waste management totals one person, resulting in a conversion factor of 2.33 and a labour coefficient of 0.4. The output product price is Rp. 280,000, with an average wage earned of Rp. 7,142. The input raw material cost used is Rp. 30,000, and other inputs amount to Rp. 13,000, producing an output value of Rp. 653,333. The added value obtained is Rp. 610,333 per production. Paper waste management uses 2 kg of raw materials and produces a product weighing 5 kg. The labour involved in the manufacturing process totals one person, resulting in a conversion factor of 2.50 and a labour coefficient of 0.4. The output product price is Rp. 200,000, with wages earned at Rp. 6,000 per kg. The raw material cost used is Rp. 18,000, and other inputs amount to Rp. 10,000, producing an output value of Rp. 500,000. The added value obtained is Rp. 472,000 per production.

Based on the above description, carbon emissions, particularly in the form of carbon dioxide (CO^2) and methane (CH^4), have become a major issue in the current global climate crisis. These gases are classified as greenhouse gases with high heat-trapping capabilities in the atmosphere, leading to rising global temperatures. In environmental management, one sector that directly contributes to greenhouse gas emissions is waste management, especially when relying on conventional systems such as open dumping and poorly managed landfills. Organic waste deposited at landfills undergoes anaerobic decomposition (without oxygen) and produces methane, a greenhouse gas with heat-trapping potential approximately 25 times greater than carbon dioxide. In Indonesia, organic waste accounts for more than half of total waste accumulation, meaning its emission potential is significant if not properly managed. Unfortunately, in many areas, including regions like Sinjai Regency, waste management practices still predominantly follow the linear "take-make-dispose" system with low recycling rates and minimal composting efforts. At the policy level, strategies must be supported by strengthening public education, improving

waste management infrastructure, and implementing digital technology for data management and recycling process monitoring. Incentives for waste-based MSMEs, digitisation of waste banks, and cross-sector collaboration are concrete steps that local governments, including Sinjai Regency, can take to achieve low-emission and sustainable waste management. Thus, waste management is no longer just about cleanliness but has become an integral part of the carbon emission reduction agenda and green economic development. Every step in sorting, processing, and recycling waste represents a real contribution to mitigating climate change and creating a healthy environment for future generations. The following table shows the conversion of waste into carbon emissions (CO_2e).

Table 9. Conversion of Waste into Carbon Emissions (CO_2e).

Waste Type/Management	Unit	CO_2e Emissions (kg)	Notes
Organic waste (landfilled)	1 tonne	±1,700 kg CO_2e	Produces methane (CH_4) from anaerobic decomposition
Organic waste (composted)	1 tonne	±30–100 kg CO_2e	Low emissions, depending on the composting method and ventilation
Organic waste (maggot farming)	1 tonne	±20–50 kg CO_2e	Lower emissions than regular composting, plus it produces animal feed
Plastic waste (open burning)	1 tonne	± 1,400 kg CO_2e	No emission control also produces hazardous pollutants
Plastic waste (recycled)	1 tonne	Avoids ±1,500–3,000 kg CO_2e	Reduces the need for new plastic production
Paper/cardboard (recycled)	1 tonne	Avoids ±1,500 kg CO_2e	Recycling paper saves energy and water
Metal/aluminium (recycled)	1 tonne	Avoids ±9,000–10,000 kg CO_2e	Aluminium recycling is far more energy-efficient than new production
Mixed waste (open burning)	1 tonne	±900–1,200 kg CO_2e	Depends on moisture content and composition

Implementation in Sinjai Regency assumes a total daily waste generation of 70 tonnes, consisting of:

a. 60% organic → 42 tonnes/day
b. 25% plastic → 17.5 tonnes/day
c. 10% paper/metal → 7 tonnes/day
d. 5% other

Simulation of emission impact (if all waste is landfilled):

a. Organic to landfill → 42 tonnes × 1,700 kg CO_2e = 71,400 kg CO_2e/day
b. Burned plastic → 17.5 tonnes × 1,400 kg CO_2e = 24,500 kg CO_2e/day
c. Other (mixed) → 10.5 tonnes × 1,000 kg CO_2e = 10,500 kg CO_2e/day

Total emissions: ±106,400 kg CO_2e per day (~106 tonnes CO_2e/day). If half is managed circularly:

a. Composting 21 tonnes → 21 × 50 kg = 1,050 kg CO_2e
b. Recycled plastic 8 tonnes → avoids ±16,000 kg CO_2e
c. Metal/paper 3.5 tonnes → avoids ±5,000 kg CO_2e

Emissions can be reduced by up to 50% or more.

Research observations conducted in Sinjai Regency show that the circular economy approach is beginning to be adopted in waste management. This approach aims to reduce waste ending up in landfills and transform waste into reusable resources. Initially, circular economy waste management uses the 3R concept as the foundation for modern waste management. Reduce involves minimising the use of materials that could become waste, such as reducing single-use plastic bag usage. In Sinjai, campaigns promoting environmentally friendly shopping bags are actively conducted in traditional markets. Reuse encourages communities to reuse items still in good condition, such as bottles, containers, or second-hand clothing. Recycling involves sorting waste for processing into new products. In several villages in Sinjai, waste banks manage plastic, paper, and metal waste for recycling.

To strengthen the system in circular economy waste management, two additional steps have been added: refuse and repair. Refuse means rejecting non-environmentally friendly products. Example: refusing plastic straws and choosing stainless steel or bamboo alternatives. Repair involves reviving the culture of fixing broken items like electronic equipment or furniture instead of immediately discarding them. The Sinjai Regency government has begun implementing most of these 9R concepts through community-based waste bank programs, providing economic incentives for residents who sort and deposit non-organic waste. Educational activities and socialisation in schools and communities introduce circular economy concepts from an early age. Additionally, partnerships with MSMEs and local artisans are encouraged to create recycled products such as bags made from plastic waste or crafts from wood waste as regional specialty products, along with zero-waste initiatives in several tourist villages or development sites. Next, circular economy waste management can be demonstrated by creating scenario modelling that is systematically and easily understood. Suitable for presentations, policy documents, or

environmental analysis in Sinjai Regency. To achieve a sustainable waste management system in Sinjai Regency, the circular economy approach can be modelled into four tiered scenarios. Each scenario illustrates the level of system advancement, ranging from conventional practices to an ideal integrated technology and green economy system.

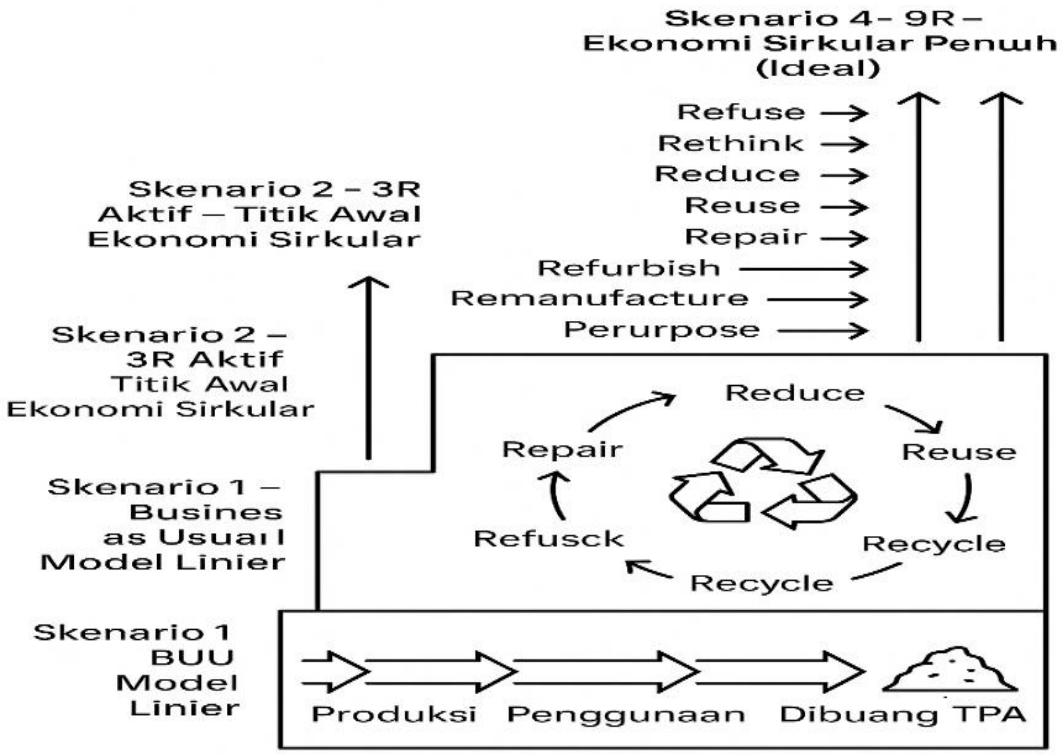

Figure 1. Circular Economy Waste Management Scenario Model

This scenario model can serve as a strategic tool in policy formulation, potential mapping, and priority needs identification for developing a sustainable waste management system in Sinjai Regency. This approach aims not only to reduce waste but also to build an inclusive and competitive local circular economy. Based on the above description, it is understood that carbon emissions are one of the main impacts of suboptimal waste management systems, particularly when still relying on landfills without prior sorting and processing. Greenhouse gases such as carbon dioxide (CO_2) and methane (CH_4) are released into the atmosphere from organic waste decomposing anaerobically in landfills. Without innovation-based interventions and a circular economy approach, the waste management sector will remain a significant emissions contributor while wasting the economic potential within the waste itself. In recent years, various local innovations have emerged in the waste management sector, beginning to shift towards a circular economy model. In Sinjai Regency, several initiatives have been implemented, such as establishing community-based waste banks, educating sorting practices in schools and villages, and involving MSMEs in transforming plastic waste into craft products. These innovations represent important initial steps but need to be expanded and strengthened to achieve significant economic and environmental impacts.

Predictions indicate that sustainable waste management will increasingly depend on digital, collaborative, and value-added innovations. Some examples of innovations already implemented and adaptable by Sinjai Regency include: Digitalisation of Waste Bank Systems: Waste bank management is developed with a digital application system that records residents' waste transactions in real-time, enabling transparency, integration with electronic payment systems, and shopping point incentives; Recycling-Based Eco-Entrepreneurship: Creative communities develop high economic value products from waste, such as fashion items made from fabric scraps, furniture from wood waste, or paving blocks from plastic waste. This model can inspire the development of waste-based MSMEs in Sinjai; Education and Youth Innovator Incubation: Developing entrepreneurship incubator programs for students and university students to create environmentally friendly startups in the waste processing sector. This concept can be replicated through collaboration between local governments, schools, and universities; Village-Scale Circular Zones: Implementing a self-sufficient circular village system where one village has communal composting systems, used cooking oil processing, and regular training for residents to transform waste into products (e.g., eco-enzymes, crafts, briquettes). This approach enables decentralisation of the waste management system, suitable for rural-suburban areas like Sinjai.

CONCLUSION

In terms of planning, organisation, implementation, and supervision, waste management through the 3R approach in Sinjai Regency has established SOPs but remains suboptimal due to various issues. These include flood-prone waste banks and low public interest in participating in the 3R waste management programme. Currently, waste management in Sinjai is not fully effective as it only involves field task forces, whereas all stakeholders should participate in supervision. The use of landfill waste disposal systems has proven ineffective due to overflowing final disposal sites, inadequate facilities, and limited budgets. As a result, waste management does not function as intended. The analysis of added value in 3R-based waste management shows potential economic benefits. This analysis is crucial as it supports environmental, economic, and social sustainability. Environmentally, it directs waste management towards reducing carbon emissions through recycling or reusing materials. It also helps identify processes that maximise contributions to waste management.

Economically, waste such as plastic, paper, and metal can be processed into higher-value products. Socially, it creates job opportunities, increases public participation in government waste policies, and supports recycling incentives or waste utilisation programmes. Carbon emissions from the waste sector pose a real threat to the environment and public health, especially with poorly managed linear systems. Implementing a circular economy is a strategic approach that not only reduces greenhouse gas emissions but also enhances economic value through recycling, reuse, and local creativity-based innovation. Currently in a transitional phase between 3R implementation and strengthening the 5R-6R system, Sinjai Regency has significant potential to improve its waste management sustainability through education, infrastructure, technology, and community engagement. Based on these findings, integrated innovation with creative economics should be a key focus for future regional strategies. Adapting successful models from other areas, such as digitalising waste banks, incubating green entrepreneurship, and developing creative waste-based products, could serve as the foundation for transforming Sinjai's waste management system. By fostering cross-sector collaboration and supporting local MSMEs in creating value from waste, Sinjai Regency has the potential to become a model region for low-emission circular economy waste management that positively impacts community welfare.

REFERENCES

R. G. Anuardo, M. Espuny, A. C. F. Costa, and O. J. Oliveira, "Toward a cleaner and more sustainable world: A framework to develop and improve waste management through organizations, governments and academia," *Heliyon*, vol. 8, no. 4, 2022, doi: 10.1016/j.heliyon.2022.e09225.

R. J. P. Schmitt, E. Morgenroth, and T. A. Larsen, "Robust planning of sanitation services in urban informal settlements: An analytical framework," *Water Res.*, vol. 110, pp. 297–312, 2017, doi: 10.1016/j.watres.2016.12.007.

I. Akomea-Frimpong *et al.*, "A bibliometric review of barriers to circular economy implementation in solid waste management," *Discov. Environ.*, vol. 2, no. 1, p. 20, 2024, doi: 10.1007/s44274-024-00050-4.

T. S. Gaur, V. Yadav, S. Mittal, and M. K. Sharma, "A systematic review on sustainable E-waste management: challenges, circular economy practices, and a conceptual framework," *Manag. Environ. Qual. An Int. J.*, vol. 35, no. 4, pp. 858–884, Dec. 2023, doi: 10.1108/MEQ-05-2023-0139.

F. Boano *et al.*, "A review of nature-based solutions for greywater treatment: Applications, hydraulic design, and environmental benefits," *Sci. Total Environ.*, vol. 711, p. 134731, 2020, doi: 10.1016/j.scitotenv.2019.134731.

Suparmini and P. Junadi, "The role of waste bank partnership in efforts to decrease waste volume in urban: A case study at a waste bank in Kalibaru, Cilodong, Depok City," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 126, no. 1, p. 12125, 2018, doi: 10.1088/1755-1315/126/1/012125.

N. A. Affandy, E. Isnaini, and A. B. Laksono, "Analysis on 3RWB model (Reduce, reuse, recycle, and waste bank) in comprehensive waste management toward community-based zero waste," *AIP Conf. Proc.*, vol. 1855, no. 1, p. 40011, Jun. 2017, doi: 10.1063/1.4985507.

Ferdinan, S. W. Utomo, T. E. B. Soesilo, and H. Herdiansyah, "Changes community behavior in management of household waste in Bekasi City, Indonesia," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 716, no. 1, p. 12071, 2021, doi: 10.1088/1755-1315/716/1/012071.

A. Kumar *et al.*, "A critical review on sustainable hazardous waste management strategies: a step towards a circular economy," *Environ. Sci. Pollut. Res.*, vol. 30, no. 48, pp. 105030–105055, 2023, doi: 10.1007/s11356-023-29511-

8.
U. Paudel, S. R. Adhikari, and K. P. Pant, "Economics of environmental effects on health: A methodological review based on epidemiological information," *Environ. Sustain. Indic.*, vol. 5, no. December 2019, p. 100020, 2020, doi: 10.1016/j.indic.2020.100020.
M. Syukur, A. Octamaya Tenri Awaru, Z. Arifin, and Anwar, "Utilization of plastic waste for poor household empowerment in Sinjai regency, Indonesia," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 1454, no. 1, p. 12031, 2025, doi: 10.1088/1755-1315/1454/1/012031.
S. Zakhilwal, W. Shirzad, and M. M. Behsoodi, "A Comprehensive Review of Engineering Strategies for Environmental Sustainability in Sustainable Waste Management," *Int. J. Curr. Sci. Res. Rev.*, vol. 07, Oct. 2024, doi: 10.47191/ijcsrr/V7-i10-02.
M. Mohammed, N. Shafiq, N. A. W. Abdallah, M. Ayoub, and A. Haruna, "A review on achieving sustainable construction waste management through application of 3R (reduction, reuse, recycling): A lifecycle approach," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 476, no. 1, p. 12010, 2020, doi: 10.1088/1755-1315/476/1/012010.
I. G. A. E. Yuliantari, "Community involvement in waste management as implementation of Regulation No. 18/2008 in the Republic of Indonesia," *Int. J. Soc. Sci. Humanit.*, vol. 4, no. 1, pp. 151–156, 2020.
N. Islam, M. Sandanayake, S. Muthukumaran, and D. Navaratna, "Review on Sustainable Construction and Demolition Waste Management—Challenges and Research Prospects," *Sustainability*, vol. 16, p. 3289, Apr. 2024, doi: 10.3390/su16083289.
R. Kansara, P. Bhojani, and J. Chauhan, "Smart waste management for segregating different types of wastes," in *Data Management, Analytics and Innovation: Proceedings of ICDMAI 2018, Volume 1*, Springer, 2018, pp. 33–46.
K. K. Mintz, L. Henn, J. Park, and J. Kurman, "What predicts household waste management behaviors? Culture and type of behavior as moderators," *Resour. Conserv. Recycl.*, vol. 145, pp. 11–18, 2019.
A. K. Awasthi *et al.*, "Zero waste approach towards a sustainable waste management," *Resour. Environ. Sustain.*, vol. 3, p. 100014, 2021.
T. Tomić and D. R. Schneider, "Circular economy in waste management–Socio-economic effect of changes in waste management system structure," *J. Environ. Manage.*, vol. 267, p. 110564, 2020.
M. Möslinger, G. Ulpiani, and N. Vetters, "Circular economy and waste management to empower a climate-neutral urban future," *J. Clean. Prod.*, vol. 421, p. 138454, 2023.
C. Casiano Flores, H. Bressers, C. Gutierrez, and C. de Boer, "Towards circular economy – a wastewater treatment perspective, the Presa Guadalupe case," *Manag. Res. Rev.*, vol. 41, no. 5, pp. 554–571, Apr. 2018, doi: 10.1108/MRR-02-2018-0056.
R. Karim, A. Waaje, M. M. Roshid, and M. B. Yeamin, "Turning the waste into wealth: Progressing toward global sustainability through the circular economy in waste management," in *Sustainable waste management in the tourism and hospitality sectors*, IGI Global Scientific Publishing, 2025, pp. 507–552.
A. Mandpe, S. Paliya, V. V Gedam, S. Patel, L. Tyagi, and S. Kumar, "Circular economy approach for sustainable solid waste management: A developing economy perspective," *Waste Manag. Res.*, vol. 41, no. 3, pp. 499–511, 2023.
C. Joshi, J. Seay, and N. Banadda, "A perspective on a locally managed decentralized circular economy for waste plastic in developing countries," *Environ. Prog. Sustain. Energy*, vol. 38, no. 1, pp. 3–11, 2019.
F. Sariatli, "Linear economy versus circular economy: a comparative and analyzer study for optimization of economy for sustainability," *Visegr. J. Bioeconomy Sustain. Dev.*, vol. 6, no. 1, pp. 31–34, 2017.
S. Upadhayay and O. Alqassimi, "Transition from linear to circular economy," *Westcliff Int. J. Appl. Res.*, vol. 2, no. 2, pp. 62–74, 2018.
K. K. Meshram, "The circular economy, 5R framework, and green organic practices: pillars of sustainable development and zero-waste living," *Discov. Environ.*, vol. 2, no. 1, p. 147, 2024.
S. J. Borah and V. Kumar, "Fundamental principles of waste management for a sustainable circular economy," in *Integrated waste management: A sustainable approach from waste to wealth*, Springer, 2024, pp. 1–11.
C. Phonthanukitithaworn, W. A. Srisathan, and P. Naruetharadhol, "Revolutionizing waste management: Harnessing citizen-driven innovators through open innovation to enhance the 5Rs of circular economy," *J. Open Innov. Technol. Mark. Complex.*, vol. 10, no. 3, p. 100342, 2024.
J. Oh and H. Hettiarachchi, "Collective action in waste management: A comparative study of recycling and recovery initiatives from Brazil, Indonesia, and Nigeria using the institutional analysis and development framework," *Recycling*, vol. 5, no. 1, p. 4, 2020.
F. Blomsma, "Collective 'action recipes' in a circular economy–On waste and resource management frameworks and their role in collective change," *J. Clean. Prod.*, vol. 199, pp. 969–982, 2018.
B. Thamilmaraiselvi, P. Bhuvaneswari, P. F. Steffi, and K. Sangeetha, "Solid Waste Management," in *Waste Management and Treatment*, CRC Press, 2024, pp. 51–61.
J. L. Stephen and B. Periyasamy, "Innovative developments in biofuels production from organic waste materials:

A review," *Fuel*, vol. 214, pp. 623–633, 2018, doi: https://doi.org/10.1016/j.fuel.2017.11.042.
H. Hettiarachchi, J. N. Meegoda, and S. Ryu, "Organic Waste Buyback as a Viable Method to Enhance Sustainable Municipal Solid Waste Management in Developing Countries," *International Journal of Environmental Research and Public Health*, vol. 15, no. 11. 2018. doi: 10.3390/ijerph15112483.
A. Pérez-Gimeno, J. Navarro-Pedreño, M. B. Almendro-Candel, I. Gómez, and A. A. Zorpas, "The use of wastes (organic and inorganic) in land restoration in relation to their characteristics and cost," *Waste Manag. Res.*, vol. 37, no. 5, pp. 502–507, 2019.
R. J. Haynes, Y.-F. Zhou, and X. Weng, "Formulation and use of manufactured soils: A major use for organic and inorganic wastes," *Crit. Rev. Environ. Sci. Technol.*, vol. 52, no. 22, pp. 4113–4133, 2022.
V. I. Osipov, "Is It Better To Incinerate Municipal Solid Waste or Degrade It?," *Her. Russ. Acad. Sci.*, vol. 91, no. 4, pp. 492–500, 2021.
H. Kirchmann, J. Nyamangara, and Y. Cohen, "Recycling municipal wastes in the future: from organic to inorganic forms?," *Soil use Manag.*, vol. 21, no. 1, pp. 152–159, 2005.
H. A. Mupambwa and P. N. S. Mnkeni, "Optimizing the vermicomposting of organic wastes amended with inorganic materials for production of nutrient-rich organic fertilizers: a review," *Environ. Sci. Pollut. Res.*, vol. 25, no. 11, pp. 10577–10595, 2018.
A. Rafey, K. Pal, K. K. Pant, E. Ahmad, and S. Upadhyayula, "Introduction to Various Types of Wastes," in *From Waste to Wealth*, Springer, 2024, pp. 3–18.
A. M. Ragossnig and D. R. Schneider, "Circular economy, recycling and end-of-waste," *Waste Management & Research*, vol. 37, no. 2. SAGE Publications Sage UK: London, England, pp. 109–111, 2019.
F. K. Saidova, "Waste recycling," *West. Eur. J. Mod. Exp. Sci. Methods*, vol. 3, no. 05, pp. 15–16, 2025.
G. Romano, A. Rapposelli, and L. Marrucci, "Improving waste production and recycling through zero-waste strategy and privatization: An empirical investigation," *Resour. Conserv. Recycl.*, vol. 146, pp. 256–263, 2019.
O. E. Ogunmakinde, W. Sher, and T. Egbelakin, "Construction waste management in Nigeria using the 3R principle of the circular economy," in *Circular Economy and Waste Valorisation: Theory and Practice from an International Perspective*, Springer, 2022, pp. 177–195.
S. Sakai *et al.*, "Waste prevention for sustainable resource and waste management," *J. Mater. cycles waste Manag.*, vol. 19, no. 4, pp. 1295–1313, 2017.
J. D. Twizeyimana and A. Andersson, "The public value of E-Government – A literature review," *Gov. Inf. Q.*, vol. 36, no. 2, pp. 167–178, 2019, doi: 10.1016/j.giq.2019.01.001.
"MITIGATING THE WASTE MANAGEMENT PROBLEM IN HAITI FROM AN ENTREPRENEURIAL STANDPOINT : A CORRELATION STUDY Madrid Francois Copyright 2022 A Dissertation Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Management in Organizatio," no. Dm, 2022.
G. Goktepeli, A. Ozgan, V. Onen, G. Ahmetli, M. Kalem, and E. Yel, "Development of sustainable resource recovery approach from agro-industrial wastes by revealing the economic added value potential," *Int. J. Environ. Sci. Technol.*, vol. 21, no. 12, pp. 7981–7998, 2024.
L. Correani, P. Morganti, I. Benedetti, and F. Crescenzi, "Insights on the social and economic factors of the circular economy: A study of the Italian industrial and urban waste recycling sector," *Waste Manag.*, vol. 193, pp. 571–580, 2025.
E. Maitre-Ekern and C. Dalhammar, "Towards a hierarchy of consumption behaviour in the circular economy," *Maastrich. J. Eur. Comp. Law*, vol. 26, no. 3, pp. 394–420, 2019.
S. Karimzadeh and M. Boström, "Ethical consumption in three stages: a focus on sufficiency and care," *Environ. Sociol.*, vol. 10, no. 1, pp. 1–11, 2024.

