Innovation in Processing Inorganic Organic Waste in Cibenda Village Parigi District Pangandaran District

Syahril[1], Adam Simbara[2], Gasper Boy[3], Rafly Fadhilah Arifhan[4], Riki Ridwan Margana[5]
Industrial Engineering Study Program, Faculty of Engineering, Widyatama University

Email: syahril@widyatama.ac.id, adam@gmail.com, gasper.boy@gmail.com, rafly@gmail.com, rika@gmail.com

Received: 2025-03-07 Received in revised from 2025-09-09 Accepted: 2025-09-29

Abstract

Waste management is a significant challenge faced by many regions, including Desa Cibenda. Population growth, urbanization, and changing consumption patterns, waste management issues have become increasingly complex. This study aims to analyze waste management in Desa Cibenda, identify key challenges, and propose sustainable solutions. Several challenges were identified, including the lack of adequate waste disposal facilities. Inefficient management methods such as burning, low public awareness regarding waste separation, and economic limitations hindering investment in waste management. As a result, a large amount of waste is disposed of improperly, polluting the environment and reducing recycling potential. Desa Cibenda covers an area of 759.319 hectares, with a population of 8,229 people in 3,028 households, generating an average waste volume of 1.67 kg/person/day. Waste composition data from segregation showed 150 kg/day. Measurements were conducted using the load count analysis method, with three-wheeled vehicles that have a capacity of 200 kg/m³ used for waste transportation. This study recommends the procurement of a waste shredder to enhance the efficiency of organic and inorganic waste management. Other recommendations include providing adequate waste management facilities, educating the community on waste separation, and adopting community-based approaches to raise awareness and establish sustainable waste management practices.

Keywords: *Community Awareness; Desa Cibenda; Recycling; Waste Management; Waste Shredding Machine*

1. Introduction

Environmental pollution is increasingly rising due to various factors, including the growth of the human population, which impacts the increase in waste generation. This situation is exacerbated by the limited availability of waste disposal facilities, low public awareness and willingness to manage and dispose of waste properly, and minimal understanding of the benefits of waste management. Additionally, there is still a reluctance among the community to reuse waste, which is often seen as something unclean and needs to be discarded, or due to prestige considerations. Inadequate waste management can contribute to environmental pollution, causing river sedimentation and potentially triggering floods. According to Jambeck [1], Indonesia ranks second globally after China in terms of plastic waste production in water bodies, with a total of 187.2 million tons of waste. This information aligns with data released by the Ministry of Environment and Forestry in 2016, revealing that plastic produced by 100 stores or members of the Indonesian Retailers Association (APRINDO) in one year reaches 10.95 million plastic bags. This result is equivalent to an area of 65.7 hectares filled with plastic waste [2]-[4].

Based on 2021 data from Cibenda Village, the village is located in Parigi District, Pangandaran Regency, West Java Province, with a fairly strategic geographical condition. The village covers an area of 759.319 hectares and is inhabited by approximately 8,229 people divided into 3,028 households. Geographically, Cibenda Village has significant territorial boundaries. To the north, it borders Bojong and Cintaratu Villages, while to the east, it borders Sukaresik Village. The southern part borders the Indian Ocean, and to the west, it borders Ciliang Village. Cibenda Village, located between rural areas and near the coast, faces waste management issues influenced by the increasing population and shifting consumption patterns of society. Waste management is a fundamental issue that demands serious attention, especially in communities experiencing rapid population growth and lifestyle changes [5].

Waste management in Cibenda Village faces increasingly complex challenges, even though the village already has a waste management system through processing facilities that apply the principles of reduction, reuse, and recycling. However, its implementation is still inefficient and does not cover all aspects of ideal waste management. The existing reduce, reuse, and recycle (TPS 3R) waste processing site currently only focuses on sorting and selling inorganic waste without further innovation. This may be due to the limited equipment supporting waste management. Moreover, kitchen or organic waste is not yet properly managed, and the method used to address this waste still relies on burning. The TPS 3R in Cibenda Village faces various challenges affecting its sustainability. Its location far from the main road and on the coast makes accessibility difficult, hampering the waste transportation process and increasing operational costs. Additionally, the small semi-permanent TPS 3R building, measuring 4 x 6 meters, is inadequate to support effective waste management, particularly in sorting, processing, and storage. Inorganic waste such as bottles, plastic bags, and cardboard, although separated for sale, is not further processed to increase its added value. Meanwhile, other types of waste are not well managed and end up being burned. Therefore, significant improvements are needed in terms of accessibility, infrastructure capacity, management methods, and regulatory compliance. Collaboration between TPS 3R managers, the government, and the community is essential to create a more efficient waste management system, preserve environmental sustainability, and ensure positive impacts for the future.

This study aims to analyze the waste management situation in Cibenda Village, including infrastructure, operational systems, and community awareness regarding the importance of waste management. Additionally, it identifies various challenges faced, both from social, economic, and technical aspects, that hinder the effectiveness of waste management. Based on the analysis, strategic recommendations are formulated to improve the management system, especially in the processing of organic and inorganic waste, to become more efficient and environmentally friendly. Finally, community-based innovations are developed that can be applied to create sustainable waste management involving active community participation.

2. Method

2.1. Research Type

This research employs a method that combines qualitative and quantitative approaches with a descriptive approach. According to Sugiyono (2018), qualitative research is used to investigate natural object conditions, where the researcher serves as the key instrument. Phenomenology is one of the approaches in qualitative research. This study focuses on an in-depth exploration of an event experienced by individuals, groups, or living beings. The interesting events in this research are part of the life experiences of the subjects under study and are examined scientifically. This method is designed to provide a deep understanding of writings, behaviors, and speech, which can be analyzed by groups, individuals, communities, or organizations within a specific context.

According to Creswell and Poth (2016), a case study is a research approach that investigates a specific phenomenon in-depth within a certain period and context, such as a program, activity, process, institution, or social group. This research is conducted by gathering detailed information through various data collection methods over a predetermined period. Case study research can be carried out with limited data sources, such as one individual, one family, or one group. Additionally, case study research can employ domain analysis techniques for assessment. In this study, the domain analysis used is a single domain, where phenomena and structures influencing one case are selected and further investigated.

2.2. Flowchart

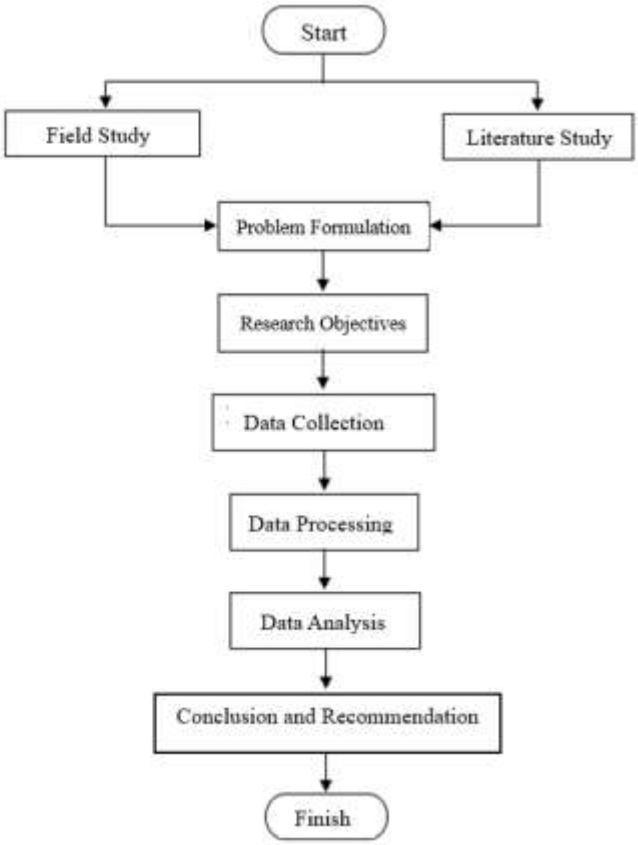

Figure 1. Research Method Diagram

The stages of this research begin with field studies and literature reviews to understand the conditions and theoretical references related to the topic. From this stage, the problem formulation is carried out to define the research focus, followed by determining the research objectives. Next, relevant data is collected during the data collection phase and then processed in the data processing phase. The results of data processing are analyzed in more depth during the data analysis stage to answer the research questions. Finally, this research produces conclusions and suggestions in the form of findings and recommendations before being declared complete. The diagram illustrating this research process shows that all stages are carried out in a structured and systematic manner. Descriptions of these research stages are shown in Figure 1.

2.3. Data Collection Techniques

The data collection techniques used include observation, interviews, and documentation. The process of data analysis and interpretation is carried out in three stages: data grouping, data structuring, and conclusion drawing (verification). Data collection is conducted through direct observation at the TPS 3R in Cibenda Village to determine the amount, type, and waste disposal patterns. Interviews are conducted with TPS 3R managers, village government officials, and local community members to understand awareness and challenges in waste management. Documentation is obtained from TPS 3R reports, government policies, and related literature to strengthen the research analysis.

2.4. Waste Generation Calculation

Data collection is carried out directly at the research site, including observations of the amount of waste received at TPS 3R, waste density, and waste composition analysis. The method used is the load count analysis, which refers to the Indonesian National Standard (SNI) 19-3964-1994. This method is an approach used to calculate the amount of waste generation. The calculation can be done by measuring the amount (weight or volume) of waste received at TPS 3R. The equation applied in this calculation is as follows:

The formulas used in this research are as follows:

T=WAT = \frac{W}{A}T=AW (1)

T=Ti×AT = T_i \times AT=Ti×A (2)

The TPS 3R, which is used as the sampling site for data collection on waste volume and composition, is selected based on the relevant service area, including households and residential complexes in Cibenda Village. The process of waste composition data collection is carried out by classifying 150 kg of waste, which is then categorized into various types of waste. These waste types consist of organic waste (food scraps, vegetable residues, fruit peels, leaves, cardboard, paper, and garden waste) and inorganic waste (plastic bottles, diapers, glass bottles, cans and metals, electronic waste, and batteries). The waste composition obtained through sampling can be categorized and visualized using diagrams.

Pi=WiW×100%P_i = \frac{W_i}{W} \times 100\%Pi=WWi×100% (3)

The amount of waste analyzed is obtained by measuring the waste volume on each three-wheeled vehicle entering the TPS 3R in Cibenda Village. The vehicles used have a carrying capacity of 200 kg/m^3. The next step is to calculate the waste density. The waste density measured includes the density on three-wheeled vehicles at the TPS 3R.

D=WVD = \frac{W}{V}D=VW (4)

Would you like to visualize the diagrams or charts for waste composition or flowcharts for this methodology?

3. Result and Discussion

The research results show that the average waste generation in Cibenda Village reaches 150.3 kg/day or approximately 1.67 kg/person/day. Compared to the national standard cited by the Ministry of Environment and Forestry (KLHK) in 2016, this figure falls into the medium category, which means it is still within acceptable limits but requires better management to prevent accumulation that could lead to environmental problems.

The implementation of activities was carried out through surveys and observations supported by direct interviews, conducted collaboratively by the TPS 3R management team in mid-August 2024. The activities were conducted over four months, from August 8, 2024, to December 8, 2024. The research team consisted of four students from Widyatama University and one supervising lecturer. The TPS 3R in Cibenda Village is managed by youth groups and housewives. This TPS 3R facility functions to process organic and inorganic waste, thereby reducing the amount of waste disposed of at the final disposal site. The profile of TPS 3R in Cibenda Village is presented in Table 1.

Table 1. Profile of TPS 3R Cibenda Village

No	Waste Treatment Facility Manager
Identity	TPS 3R Sajadu
Address	Jalan Baru Batu Hiu Blok Hecry Bagas Windu, RT 002 RW 015 Cibenda, Pangandaran, West Java
Management	Bookkeeping administration based on savings, not yet through bank accounts, savings are stored by the treasurer
Staff	10 People
Productive Sector	Management and Distribution of Inorganic Waste (Bottles)
Asset Value	Rp. 68,000,000

This observation was conducted over 28 days to obtain accurate data regarding the amount of waste produced and its characteristics. The results of this initial waste observation can be used to design a more efficient waste management strategy, including sorting, reduction, and recycling. Additionally, the collected data can provide insights into the potential use of waste for recycled products, such as paving blocks made from shredded plastic. The results of the waste observation are presented in Table 2.

Table 2. General Waste Observation

No.	Waste Management Flow	Assessed Requirements	Compliance with Assessment (Yes/No)	Observation Results Description
1	Collection	Separate bins available (organic and inorganic)	No	Still combined in one plastic bag
2	Sorting	Waste sorted according to category (organic, inorganic, hazardous waste)	No	Still combined in one plastic bag
3	Transportation	Waste transported on schedule and according to procedure	Yes	Collected twice a week on Mondays and Thursdays
4	Processing	Organic waste processed into compost or biogas	No	Currently, organic waste is burned with an incinerator as it holds no economic value
5	Final Disposal	Inorganic waste disposed of at the landfill according to regulations	No	Economically valuable inorganic waste is collected and sold, while non-valuable waste is still stored

The measurement of waste generation volume was carried out over 28 days. Based on the analysis results, the volume of waste generation in each area showed variations corresponding to their respective capacities. The data obtained is presented in Table 3.

Table 3. Waste Observation Data

No.	Parameter	Amount	Description
1	Number of Waste Bank Members	90 households	Total households registered in the waste bank.
2	Total Average Waste Per Day	1.5 quintals (150 kg)	Total amount of waste generated daily.
3	Organic Waste	45 kg	30% of the total waste (1.5 quintals).
4	Inorganic Waste	105 kg	70% of the total waste (1.5 quintals).

Based on the collected data, the total waste generation produced over the 28-day period can be calculated to provide useful information in determining the frequency of waste collection, the capacity of waste bins needed, and the potential for implementing waste reduction or recycling programs in each area. The amount of waste is calculated based on the volume capacity of the waste received at the TPS 3R, then multiplied by the waste density. The waste weight of 1.67 kg per person per day is obtained from the average total daily household waste divided by the number of waste bank members or the number of households in Cibenda Village, using load count analysis on three-wheeled vehicles. The waste generation calculation can be seen in the data obtained from TPS 3R as follows.

$$
\begin{aligned}
\mathrm{T} &= \frac{W}{A} \\
&= \frac{150.3\ \mathrm{kg}}{90} \\
&= 1.67\left(\frac{kg}{\mathrm{hari}}\right)
\end{aligned}
$$

$$
\begin{aligned}
\mathrm{T} &= \mathrm{Ti} \times \mathrm{A} \\
&= 1.67 \times 90 \\
&= 150.3\left(\frac{\mathrm{kg}}{\mathrm{hari}}\right)
\end{aligned}
$$

According to the Ministry of Environment and Forestry (KLHK, 2021), the average waste generation per capita in Indonesia ranges between 0.7 - 2.5 kg/person/day. Thus, the figure of 1.67

kg/person/day found in Cibenda Village falls into the medium category, indicating that household waste production in this village is still relatively high and requires more efficient waste management strategies.

$$\mathrm{Pi} = \frac{\mathrm{Wi}}{\mathrm{W}} \text{ x } 100\%$$

$$= \frac{45}{150.3} \text{ x } 100\%$$

$$= 29.9\ \%$$

$$\mathrm{Pi} = \frac{\mathrm{Wi}}{\mathrm{W}} \text{ x } 100\%$$

$$= \frac{95}{150.3} \text{ x } 100\%$$

$$= 69.8\ \%$$

According to Purwanti's study (2021), in urban areas, organic waste can account for 50-60% of the total waste generation. However, in Cibenda Village, inorganic waste is more dominant (70%), which is likely due to the high consumption of plastic packaged products and the low practice of waste sorting by the community. Therefore, raising awareness about waste sorting is an essential step in improving the waste management system in the village.

$$\mathrm{D} = \frac{\mathrm{W}}{\mathrm{V}}$$

$$\text{Example of calculation} = \frac{430\ (\mathrm{kg})}{2.12\ (\mathrm{m}^3)}$$

$$= 202.8\ \mathrm{kg/m}^3$$

According to Halimah et al. (2022), the average waste density in urban areas can reach 200-400 kg/m³, while at TPS 3R Cibenda Village, it is lower, at 150 kg/m³. This indicates that the collected waste is still loose and can be further compressed for storage efficiency. With a density lower than the national standard, steps to improve the efficiency of the compaction and processing system at TPS 3R are highly necessary to optimize storage space utilization.

The following table presents the amount of waste over one month in Cibenda Village, based on direct field observations.

Table 4. Waste Amount Data for One Month

Week	Collection Day	Amount of Waste Collected (quintals)
1	Monday	4.5
Thursday	3.7	
Weekly Total		
2	Monday	3.8
Thursday	4.1	
Weekly Total		
3	Monday	4.3
Thursday	4.2	
Weekly Total		
4	Monday	3.6
Thursday	3.9	
Weekly Total		
Total Amount		
Average/Week		

Waste can be categorized into two main types: organic waste and inorganic waste. Waste composition data is essential in designing more efficient waste management strategies. The percentage of waste composition generated in Cibenda Village can be seen in Table 5.

Table 5. Percentage of Waste Composition in Cibenda Village

Type of Waste	Percentage (%)
Organic Waste	30
Food Waste	10
Vegetable/Fruit Waste	5
Leaves and Garden Waste	5
Cardboard and Paper	10
Inorganic Waste	**70**
Plastic (Plastic Bottles, etc.)	35
Diapers	15
Glass Bottles	10
Cans and Metal	5
Electronic Waste and Batteries	5

According to Table 5, plastic bottles are the most dominant type of waste received at the TPS 3R. This is due to the significantly higher volume of plastic waste compared to other types of waste, such as cardboard, paper, and metal. The current waste management system focuses on classifying waste at the TPS 3R. Organic waste is processed by incineration, while inorganic waste is further sorted to determine which materials have economic value. The current waste management scheme is shown in Figure 2.

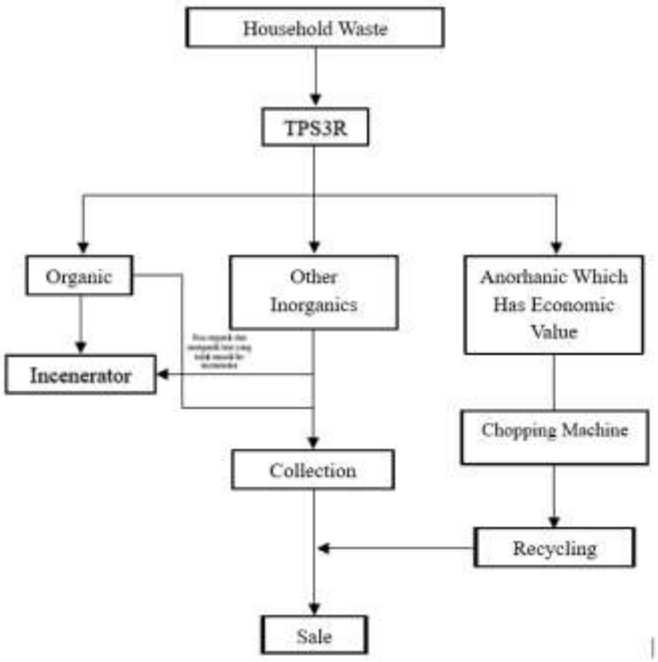

Figure 2. Current Waste Management Scheme

To overcome the limitations of the previous scheme, an innovation was made to the new waste management system. In this scheme, an additional process for inorganic waste treatment was introduced to improve efficiency and economic value. Inorganic waste that was previously not utilized is now processed through a shredding machine, allowing the material to be recycled. The diagram of the new waste management scheme is shown below.

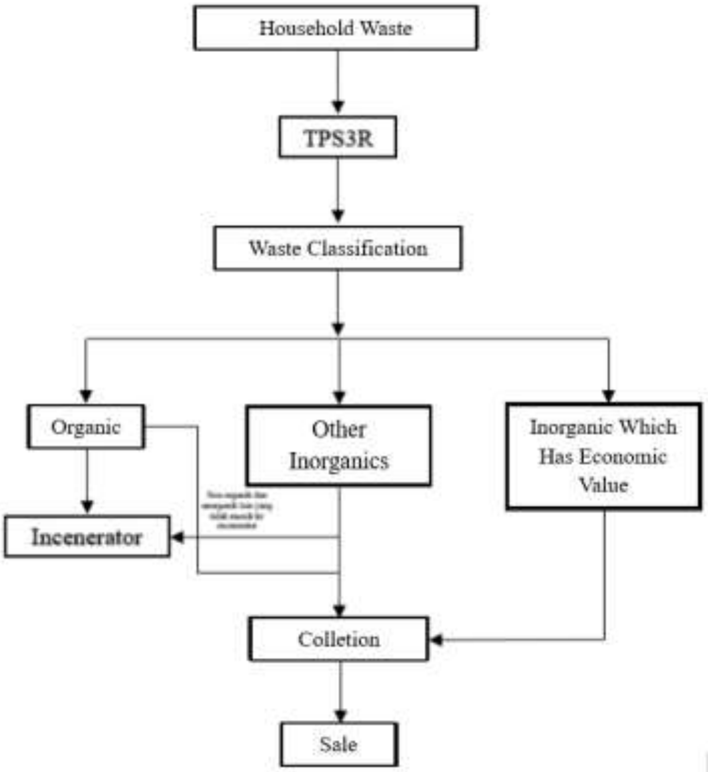

Figure 3. New Waste Management Scheme

The inorganic waste shredding machine was designed by Universitas Widyatama. This machine not only functions to crush inorganic waste but also produces materials that can be recycled into new, higher-value products. Additionally, the shredding machine has great potential for use in organic waste processing, providing flexibility in managing various types of waste. This scheme not only contributes to environmental sustainability but also creates economic opportunities through recycling activities at the TPS 3R in Cibenda Village.

In the new waste management scheme, the addition of the waste shredding machine enables more efficient processing compared to the previous method, which relied solely on manual sorting. A study conducted by Purwanti (2021) shows that the use of shredding machines can improve inorganic waste management efficiency by up to 40%, making this scheme expected to reduce the amount of waste ending up in landfills. Moreover, the community-based system applied in the new TPS 3R management is expected to increase community participation in waste sorting at the source, as highlighted by Yasin, A., & Pratiwi, D. I. (2024), who state that active community involvement is a key factor in the success of sustainable waste management systems.

4. Conclusion

Based on the findings of the conducted research, it can be concluded that the average household waste generation in Cibenda Village is 1.67 kg/person/day, with an average daily waste volume of 150.3 kg/village and a total of 3,210 kg or 3.21 tons of waste collected in one month. The waste composition percentage shows 30% organic waste and 70% inorganic waste.

To address this issue, this research recommends strategic measures, including the provision of better waste management facilities, community education on the importance of waste sorting, and the design of a shredding machine that meets these needs. The use of a waste shredding machine will support the processing of both organic and inorganic waste into more economically valuable products. A community-based approach is proposed to enhance public awareness and optimize sustainable waste management. This solution is expected to significantly reduce environmental impact while increasing the economic value of managed waste.

References

[1] Aini, A. N., Riyati, N., Restiandika, F., & Lestari, R. A. (2018). Plastik Biodegradable Limbah Nasi. *Prosiding SNTK Eco-SMART*, *1*(1).

[2] Anita, A., & Astuti, S. I. (2022). Digitalisasi Dan Ketimpangan Pendidikan: Studi Kasus Terhadap Guru Sekolah Dasar Di Kecamatan Baraka. *Jurnal Pendidikan Dan Kebudayaan*, *7*(1), 1-12.

[3] Creswell, J. W., & Poth, C. N. (2016). *Qualitative Inquiry And Research Design: Choosing Among Five Approaches*. Sage Publications.

[4] Dewanti, M., Purnomo, E. P., & Salsabila, L. (2020). Analisa Efektifitas Bank Sampah Sebagai Alternatif Pengelolaan Sampah Dalam Mencapai Smart City Di Kabupaten Kulon Progo. *Jurnal Ilmu Administrasi Publik*, *5*(1), 21-29.

[5] Hariyanti, Y., Susanto, J., Alfarisi, I., Chotib, M., & Anggraini, Z. (2022). Mekanisme Pengangkutan Sampah Di Kecamatan Pasar Muara Bungo Kabupaten Bungo. *Jurnal Reformasi Administrasi: Jurnal Ilmiah Untuk Mewujudkan Masyarakat Madani*, *9*(2), 94-104.

[6] Halimah, N. N., Purwaningrum, P., & Siami, L. (2022). Kajian Timbulan, Komposisi Dan Nilai Recovery Factor Sampah Di TPS 3R Kampung Injeuman, Desa Cibodas. *Jurnal Serambi Engineering*, *7*(4).

[7] Jambeck, J. R. (2018). The Chinese Import Ban And Its Impact On Global Plastic Waste Trade. Science Advances , 4 (6) . Https://Www.Science.Org/Doi/Abs/10.1126/Sciadv.Aat0131

[8] Khotimah, A. H., & Fitri, R. A. (2025). Dinamika Struktur Organisasi: Implikasi Efektivitas Dan Efisiensi Operasional. *CAKRAWALA: Management Science Journal*, 12-21.

[9] Najdah, N., & Nurbaya, N. (2021). Inovasi Pelaksanaan Posyandu Selama Masa Pandemi Covid-19: Studi Kualitatif Di Wilayah Kerja Puskesmas Campalagian. *Jurnal Kesehatan Manarang*, *7*(Khusus).

[10] Pahleviannur, M. R., De Grave, A., Saputra, D. N., Mardianto, D., Hafrida, L., Bano, V. O., ... & Sinthania, D. (2022). *Metodologi Penelitian Kualitatif*. Pradina Pustaka.

[11] Purwaningrum, P. (2016). Upaya Mengurangi Timbulan Sampah Plastik Di Lingkungan. *Indonesian Journal Of Urban And Environmental Technology*, *8*(2), 141-147.

[12] Purwanti, I. (2021). Konsep Dan Implementasi Ekonomi Sirkular Dalam Program Bank Sampah Studi Kasus: Keberlanjutan Bank Sampah Tanjung. *Amanu: Jurnal Manajemen Dan Ekonomi*, *4*(1), 89-98.

[13] Putra, W. T. (2020). Pemberdayaan Masyarakat Melalui Pengelolaan Sampah Di Bank Sampah. *Jambura Journal Of Community Empowerment*, 69-78.

[14] Santoso, S. B., Margowati, S., Dyah, K., Pujiyanti, U., Pudyawati, P. E., & Prihatiningtyas, S. (2021). Pengelolaan Sampah Anorganik Sebagai Upaya Pemberdayaan Nasabah Bank Sampah. *Community Empowerment*, *6*(1), 18-23.

[15] Sugiyono. 2018. Metode Penelitian Kuantitatif. Bandung: Alfabeta.

[16] Sundari, S., Yuspradana, R., Irwanto, S., & Pratama, R. A. (2024). Desain Mesin Pencacah Sampah Organik Kapasitas 20 Kg Dalam Mendukung Produksi Eco-Enzyme Dan Kompos. *Insologi: Jurnal Sains Dan Teknologi*, *3*(3), 315-324.

[17] Surya, A. S., Azharul, F., & Arso, W. (2019). Rancang Bangun Alat Penghancur Sampah Organik Skala Rumah Tangga. *Journal Of Mechanical Engineering Manufactures Materials And Energy*, *3*(2), 92-99.

[18] Yasin, A., & Pratiwi, D. I. (2024). Pemberdayaan Masyarakat Dalam Pengelolaan Sampah Berkelanjutan: Studi Kasus Di Kampung Salo Kendari.