Design of Waste Processing System in Slum Area by 3R Waste Treatment Site (Case Study: Tangerang City, Indonesia)

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Abstract

This design contains the process of designing a Reduce, Reuse, Recycle (3R) Waste Processing Facility that can handle residential waste in Selapajang Jaya Sub-district. The objective of this design is to create a recommendation for a 3R Waste Processing Facility that complies with the 3R Waste Processing Facility Technical Guidelines and can reduce waste volume before being transported to the Landfill (TPA). Additionally, the design includes a budget plan covering investment costs, operational and maintenance costs, and assumptions about the revenue received by the 3R Waste Processing Facility. There are 3 design alternatives that will be selected using the Utility Theory and Compromise Program methods. The chosen best alternative involves processing organic waste using hollow brick boxes and plastic waste using a shredder machine. This design is capable of handling a waste generation of 22.449 m3/day from 1.952 households in Selapajang Jaya Sub-district. The facility includes waste sorting area, residue storage area, plastic waste processing area, organic waste processing area, warehouse, office, security post, and toilets. Theoretically, this 3R Waste Processing Facility can reduce the amount of waste by 61.17%. The design requires an investment cost of Rp 434,370,815 with a monthly operational and maintenance cost of Rp 45,781,470, and an estimated monthly revenue of Rp 94,148,061 for the 3R Waste Processing Facility.

Keywords: household waste, 3r waste processing facility, slums, utility theory and compromise program, budget design.

Introduction

According to Law Number 18 of 2008 of Republic of Indonesia, solid waste is the residue of daily human activities and/or natural processes in solid form. Solid waste is one of the serious problems in Indonesia that requires handling not only from the central government but also local governments. In 2018, the waste generation in Tangerang City per day reached 1,400 tons (Aulia, 2018). The waste generated in each sub-district will end up in the Rawa Kucing Final Processing Site. The Rawa Kucing TPA is only able to process 1,060 tons of the 1,400 tons of waste generated per day (Kusumawardhani, 2017). The volume of waste generation will certainly increase in line with the increasing population in Tangerang City. In addition, the problem of solid waste can also cause the growth of slum areas in Tangerang City.

Definition of slum area can be viewed from several aspects, namely buildings, roads, clean water supply, drainage, waste-water management, waste management, and fire protection (Ministerial Regulation Number 14 of 2018 of Minister for Public Works and Human Settlements). Specific to Tangerang City, Banten, Indonesia, there are 27 urban villages that fall into the slum category with severe, medium and low slum classifications (According to the Decree of the Mayor of Tangerang Number 663 of 2016 concerning Designation of Housing and Slum Areas in the Tangerang City Area). Sub-districts that fall into the category of severe slums have been handled by the Minister for Public Works and Human Settlements, while sub-districts that fall into the category of moderate and light slums have not been handled. One of the sub-districts with the moderate category is Selapajang Jaya. Then, referring to the 2015-2019 Tangerang City Sanitation Strategy and the 2014 Tangerang City Sanitation White Paper, Selapajang Jaya Village is one of the sub-districts included in the Strata 4 category. The stratum 4 classification is meant for areas that have poor waste management conditions, that is, apart from being disposed of in temporary dump site, waste disposal is also carried out by burning, letting the waste decompose, and dumping it in rivers/lakes so that it can be said that Selapajang Jaya Village has a high risk in its waste sector. These three behaviors can certainly trigger environmental pollution such as soil pollution, groundwater pollution, and air pollution (Sayuti, 2017). Therefore, further handling is needed regarding waste management in Selapajang Jaya Village.

Based on the Tangerang City Solid Waste Management Masterplan (2012) it is stated that one way to deal with waste problems is to improve a good 3R (Reduce, Reuse, Recycle) program. The improvement of the 3R program can be carried out by building community-based 3R Waste Treatment Sites (TPS 3R) in each village. The implementation of TPS 3R is carried out not only because it can reduce waste in an area, this waste processing also has direct economic benefits by selling the results of composting and materials such as plastic, metal and glass which have high economic value (Anisa, Hartono, & Nazech, 2014). This is in line with Setyaningsih & Caroline, 2016 which states that the presence of TPS 3R can reduce waste generation in Mulyorejo District, Surabaya by 70.5%. In addition, in Abidin, 2018 it was also stated that the existence of TPS 3R can empower and improve the economy of the surrounding community, especially those who manage TPS 3R with income from selling processing results at TPS 3R. Furthermore, processed products in the form of compost can also be used for greening in the village. Therefore, the design of TPS 3R in Selapajang Jaya sub-district is expected to be able to deal with waste problems so that the level of slums is reduced and the standard of living of the surrounding community is increased. In addition, TPS 3R is also expected to contribute fo reducing the volume of waste generation that goes to the Rawa Kucing final processing site.

This study aims to design a waste processing system through 3R waste treatment site includes waste receiving areas, sorting areas, waste storage areas, organic waste processing areas, plastic waste processing areas, warehouses, toilets, offices and guard posts. The design is carried out for the scope of domestic waste according to the availability of existing land, which is 837.98 m^2 for the 10 years design. The design is expected to be able to contribute to reducing the volume of domestic waste in Selapajang Jaya Village which will be transported to Rawa Kucing landfill, extend the age of the landfill, provide economic benefits to the people in Selapajang Jaya sub-district, and take into consideration by the local government for the city planning.

Methods

This study used secondary data from various sources, namely population data from the Tangerang Statistics Center, waste generation data from the Tangerang City Environmental Service, data on spatial plans for the city of Tangerang, as well as supporting secondary data from various websites. The data that has been collected is processed and analyzed in the following ways:

1. Population projection and waste generation

Population projection can be done by 3 (three) methods, namely arithmetic method, geometric method, and exponential method. The geometric method was chosen to project the population in within the next 10 years. After projecting the population, the next step is to calculate the projection of solid waste generation. Solid waste generation projections can be calculated by multiplying the average solid waste generation by the previously calculated population projection data.

2. Cost estimation

Cost estimation includes investment and operational costs. In Investment costs, materials used in the construction process, the cost of construction workers, and the procurement of processing equipment needed during the operational process are taken into account. Meanwhile, operational and maintenance costs are considering workers' wages, the cost of purchasing processing needs, and the cost of maintaining processing equipment.

This design considers the area of land available for the construction of the 3R waste processing site, the volume of waste generation generated by Selapajang Jaya, the composition of waste, the increasing amount of waste generation each year and the condition of the Rawa Kucing Landfill which has limited land in implementing a sanitary landfill system, as well as the need for better waste management to reduce the level of slums in Selapajang Jaya. The design of waste processing using TPS 3R can be technically feasible if it meets the requirements listed in the TPS 3R Technical Guidelines, namely being able to serve a minimum of 400 households with a minimum land area of 200 m2. In this design, TPS 3R must at least have a mixed waste outpouring area, a waste sorting area, an organic waste processing area, an inorganic waste processing or storage area (recycling), and an inorganic waste processing/storage area (residues).

Results

1. Existing Condition of solid waste Management in Selapajang Jaya Sub-District

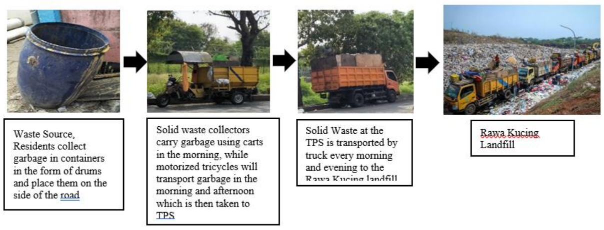


Figure 1. Existing Condition of solid waste Management

Based on the results of interviews with the Selapajang Jaya Sub-District's officers in November 2020, waste storage is carried out using drums or bamboo baskets which are used to collect waste from several houses. There are 14 trash carts available which are collected every day from 05.00 to 07.00 West Indonesia time. Meanwhile, transportation using a bentor is carried out every day with two trips, namely at 05.00 and 13.00. Bentor is used to transport garbage in areas that cannot be passed by dump trucks. Garbage that has been transported will be taken to temporary dump site (TPS). Selapajang Jaya sub-district has 3 TPS with a size of 2 m x 1.5 m which can only accommodate about 3 m^3 of waste generation per day at each TPS, which is still not sufficient to accommodate the amount of waste generation per day, 40,362 m^3. Garbage at the TPS will be transported back by dump trucks to Rawa Kucing landfill.

2. Evaluation of Existing Condition

Regarding the alignment of the existing conditions of waste management in Selapajang Jaya sub-district with regulations, the waste management that has been implemented in Selapajang Jaya was compared to Indonesian Government Regulation Number 81 of 2012 concerning Management of Household Waste and Household-like Waste.

- Waste separation: the government represented by the sub-district has provided segregated waste containers at several points which are divided into three types of waste, namely organic waste, non-organic waste and hazardous waste. However, the community has not been sorting according to the type of waste because there is still waste that is not in the right container. In addition, the containers in each house have not yet been segregated so that all types of waste are still mixed together.
- Waste collection: The regulations state that the waste collection facilities that must be provided are TPS and/or TPS 3R and/or collection devices for segregated waste. In its implementation, the sub-district has provided a TPS as a waste collection location with a daily collection and transportation schedule, but the area and capacity of the available TPS is not sufficient to accommodate the amount of waste generated by the surrounding community every day. From the results of observations, this triggers people to burn their waste or dispose of waste carelessly, such as on vacant land or on riverbanks.
- Waste transportation: The regulations state that waste transportation is carried out by providing a means of transporting waste to the TPS and transporting it from the TPS to the landfill. In its implementation, trash carts and bentors are ready to transport the waste generated by the community to the TPS. Later, the garbage that has been collected at the TPS will be transported using a dump truck to the TPA.
- Waste processing: The regulation states that waste processing must be carried out by providing processing facilities in the form of TPS 3R. In its implementation, Selapajang Jaya sub-district does not yet have a waste processing facility in the form of a 3R TPS, but only a TPS as a waste collection facility. The absence of TPS 3R causes waste to only be collected without any prior processing before being transported to the landfill.
- Economic aspect: based on the existing conditions that occurred in Selapajang Jaya,

where there was no 3R TPS in the area, it was assumed that no profit was obtained.

3. Population Projection

Population data is projected using 3 (three) methods, namely the arithmetic method, the geometric method, and the exponential method needed to estimate the amount of waste generation that will be generated in the future. From this comparison, it is possible to select the most appropriate method for projecting the population of Selapajang Jaya. The chosen method is a method that has a correlation coefficient close to 1 with the smallest standard deviation (Widayani, 2016). Based on this, the chosen method is the geometric method with a correlation coefficient of 0.208 and a standard deviation of 1693.556. Furthermore, population projections for the next 10 years are carried out in Selapajang Jaya using the geometric method. Historical data of population from 2010-2019 and projections up to 2029 can be seen in Table 1 and 2.

Table 1. Historical Data of Population of Selapajang Jaya Sub-District

Year	**Population**	**Source**
2010	13350	Tangerang city statistics center agency, 2010
2011	16755	Tangerang city statistics center agency, 2011
2012	17027	Tangerang city statistics center agency, 2012
2013	17265	Tangerang city statistics center agency, 2013
2014	17273	Tangerang city statistics center agency, 2014
2015	17387	Tangerang city statistics center agency, 2015
2016	17481	Tangerang city statistics center agency, 2016
2017	17552	Tangerang city statistics center agency, 2017
2018	17533	Tangerang city statistics center agency, 2018
2019	17549	Tangerang city statistics center agency, 2019

Table 2. Population Projection of Selapajang Jaya Sub-District

Year	**Population Projection**
2020	18138
2021	18746
2022	19375
2023	20024
2024	20696
2025	21390
2026	22108
2027	22849
2028	23615
2029	24408

4. Estimation of Waste Generation

Based on population data in Selapajang Jaya, it is known that the village is classified as a small town according to SNI-19-3964-1994 with a population of between 3,000 and 500,000 residents which means that the unit for waste generation for small town classification is 2.3 L/person/day. The calculation of projected waste generation is done by multiplying the unit of waste generation by the projected population. The waste generation projected can be seen in Table 3.

Table 3. The waste generation projected of Selapajang Jaya Sub-District

Year	**Population (person)**	**Waste generation (L/person/day)** [1]	**Mass of Waste (kg/person/day)** [1]	**Volume of waste (L/day)**	**Volume of Waste (m^3/day)**	**Mass of Waste (ton/day)**
2020	18137	2,3	0,4	41715	41,715	7,3

2021	18745	2,3	0,4	43113	43,113	7,5
2022	19373	2,3	0,4	44558	44,558	7,7
2023	20023	2,3	0,4	46052	46,052	8,0
2024	20694	2,3	0,4	47595	47,595	8,3
2025	21387	2,3	0,4	49190	49,190	8,6
2026	22104	2,3	0,4	50839	50,839	8,8
2027	22845	2,3	0,4	52543	52,543	9,1
2028	23610	2,3	0,4	54304	54,304	9,4
2029	24402	2,3	0,4	56124	56,124	9,8

5. Selection of Designated TPS 3R Location

TPS 3R is planned to be built in the RT 005/003 area, which is right next to Jl. Marshal Surya Darma. The TPS 3R location was chosen because the availability of sufficient land and the location was next to a major road making it easier to transport residual waste by dump trucks. In addition, this location was also chosen because it is close to residential areas and around the area there are still residents who burn garbage and dispose of it indiscriminately. This selection refers to Public Work and Human settlements Ministerial Regulation Number 3 of 2013 which states that the 3R TPS location is not far from the source of waste and has easy access. The TPS 3R building will be built on an area of 837.98 m^2. The land area is obtained based on the calculation of the area using Google Earth.

6. Design Alternatives

There are three (3) design alternatives proposed in this study which will be chosen using method of utility theory and compromise program. These methods were chosen because it has small interpretation range making it easier to evaluate each parameter. In addition, the Utility Theory method was used to get the most ideal alternative that can be applied. However, this ideal condition is difficult to obtain in real conditions because several factors can influence it, so a recalculation is needed using the Compromise Program method so that the selection of these alternatives can be carried out in a realistic way and the selected alternative solutions can be applied to real conditions (Fishburn, 1990).

TPS 3R will later receive the waste that has been transported by the garbage cart, then the waste will go through a sorting process. The type of waste that is sorted refers to the composition of the largest waste produced, namely organic waste and plastic waste. In addition, waste sorting is also carried out for waste that has a sale value, including paper waste, metal waste, and glass waste (Siswadi, 2015). Waste that does not meet these criteria will be considered as residue and will be placed in a special container for further storage before being transported by truck to the landfill. Paper, metal and glass waste that has been sorted will then be directly stored in a warehouse before being sold, while organic waste and plastic waste will first go through a processing process to then be sold in new products. The selection of alternatives focuses on the processing methods and technologies that will be used in TPS 3R to process organic waste and plastic waste.

- Alternative 1

In this alternative, the organic waste that goes into TPS 3R will be composted using the bamboo windrow aerator method. In this method the waste will be stacked openly by forming a windrow, in the middle there will be an aeration device made of bamboo. This tool aims to help supply air into the pile of waste so that the aeration process takes place properly and does not easily experience anaerobic conditions (Damanhuri & Padmi, 2015). When compared to other methods, this method is relatively cheap because it only requires bamboo and EM4 (effective microorganism) to help the waste decomposition process. Meanwhile, plastic waste will be processed using a melting machine and a plastic chopping machine to produce chopped plastic. A melting machine can be used to melt not only plastic bottles but also plastic waste in the form of food wrappers and plastic bags (Cresek) (Mesin Sakti, 2020). This of course can increase the amount of plastic waste that can be recycled thereby increasing the amount of waste reduction at TPS 3R.

- Alternative 2

This alternative will combine the composting method with stacking takakura and waste compaction machines as processing for plastic waste. The stacking takakura method is carried out by placing chopped organic waste into baskets that already contain cardboard, husk pads, and bran (Warjoto, Canti, & Hartanti, 2018). The presence of cardboard, husk pads, and rice bran aims to reduce water content because these materials can absorb excess water in piles of waste so that humidity during the composting process can be maintained (Damanhuri & Padmi, 2015). In addition, the composting process with this method can also take place quickly with portable composting tools (Warjoto, Canti, & Hartanti, 2018). Then, plastic waste management will be carried out by compacting it using a garbage compaction machine. Compaction of waste aims to compress plastic waste to make it more efficient in storage and also to reduce transportation costs if it is sent to third parties for further processing (Jannah, 2019).

- Alternative 3

The processing that will be applied to this alternative is the composting method using hollow brick boxes and a plastic waste chopping machine without any previous melting process. Composting with hollow brick boxes is carried out by piling chopped organic waste in a brick box structure with cavities that function to circulate air into the waste pile (Directorate General of Cipta Karya, 2017). Apart from the cavities in the bricks, airflow into the compost can also come from pipes in the box. The amount of air flow into the compost can prevent the occurrence of anaerobic processes. In addition, with the help of perforated pipes and cavities in the bricks, the need for turning can be reduced, making it easier for operations to take place. A neat impression can also be seen during the composting process because of the piles of trash placed in it. Then, for plastic waste, it will be processed using a chopping machine until it becomes chopped plastic. The use of this chopping machine was chosen because plastic waste that can be processed by an industry must be in the form of fractions, granules, seeds, or powder (Yahya, 2017).

7. Selection of the Best Alternative

The first step that needs to be done is to set the assessment parameters. The three alternatives will be assessed based on the land requirements for the applied treatment, the workload of the employees, the costs required to procure the equipment, the odor from the composting process, and the products produced from the applied processing. After determining the assessment parameters and value conversions, the next step is to evaluate the three alternatives based on predetermined parameters and value conversions. After converting the values, the best and worst values are obtained for each assessment parameter. The next stage is the weighting of each assessment parameter and standardization of the weighting. the final step is to perform calculations on the three alternatives to obtain utility values and indicator values from the Utility Theory and Compromise Program methods which will then be ranked to obtain the selected alternative solutions that will be implemented in TPS 3R. Based on the calculation results of these steps, it is found that Alternative 3 which uses the hollow brick box method and the chopping machine is the best alternative among the other alternatives.

8. Design Calculation

- The hourly waste processing load at TPS 3R can be determined by considering the ability of TPS 3R to accommodate the incoming waste volume, which is 40% of the total waste or 22,449 m3/day. TPS 3R is planned to have an operational time of 7 hours per day referring to Law Number 13 of 2003.

$$Loading\ rate = \frac{\text{Volume of } input\ waste\ (\text{m}^3/\text{day})}{\text{Operational time (hour/day)}}$$

$$= \frac{22{,}449\ \text{m}^3/day}{7\ hour/\text{day}} = 3{,}207\ \text{m}^3/\text{jam}$$

- Separation Waste Area

Garbage carts and bentors will unload the waste transported in the sorting area. In this area, officers will sort waste into 5 types, namely organic waste, plastic waste, paper waste, metal waste, and glass waste. In accordance with PUPR Ministerial Regulation Number 3 of 2013, the number of workers who will carry out the sorting is 4 people. Calculation of the area of the sorting area can be seen in Table 4 with the adjustment of the dimensions on the width of the pile due to considering the aesthetic aspect when preparing the layout of the area.

Tabel 4. The Calculation of Separation Waste Area

Parameter	Calculation	Dimension	Unit
Waste Generation		22,449	m^3/day
Space*		1	m
Stack Width		5,464	m
Stack Height**		0,3	m
Waste Area*	Volume of waste/Stack Heigh	74,83	m^2
Length*	Waste Area/Stack Width	13,695	m
Area*	(Length+Space) x (Width+Space)	94,989	m^2

- Residue Storage Area

Solid waste that is not included in the type of waste that is sorted will be considered as residue. The residue will be transferred to a special storage area for further transport to the landfill. Residue storage containers will be placed adjacent to the sorting area to facilitate the process of moving and transporting. Referring to research conducted by Sarasati (2013), residue storage time is carried out for 1 day which is also listed in PUPR Ministerial Regulation Number 3 of 2013. Calculation of the area of residue storage area can be seen in Table 5 with the width of the area adjusting to land conditions and in terms of aesthetics at the time of arrangement of the layout of each area.

Table 5. The Calculation of Residue Storage Area

Parameter	Calculation	Dimension	Unit
Volume of Solid Waste		8,605	m^3/day
Storage Duration*		1	hari
Height**		0,5	m
Width		5,464	m
Space**		1	m
Volume of waste after storage		8,605	m^3
Area of waste*	Volume of waste stored/Stack Height	17,209	m^2
Length*	Area of waste/width	3,150	m
Area*	(Length+Space) x (Width+Space)	26,823	m^2

- Organic Waste Processing Area

Sorted organic waste will be taken directly to the organic waste processing area. There are three areas in it, namely the crushing area, the composting area, and the sieving and packaging area. The selection of the chopping machine is based on the calculation of the weight of the organic waste to be processed per hour. Calculation of the weight of organic waste processed per hour refers to Sarasati (2013) with the following calculations:

Mass of organic waste processed = $\frac{\text{Mass of organic waste (kg/day)}}{\text{working hour (hout/day)}}$

$= \frac{1849{,}017 \text{ kg/day}}{7 \text{ hour}/day} = 264{,}145$ kg/hour

From these calculations, it is found that the weight of organic waste to be chopped per hour is 264.145 kg/hour. Based on Astro Machine (2020), the type of machine capable of processing 164.145 kg/hour of waste is ADR APPO 1615 with a capacity of 300-500 kg/hour.

Garbage that has been chopped will go into the composting process. Composting was carried out using the hollow brick box method according to the selected alternative. In this area there will be 4 officers who will manually turn over the waste and routinely check the compost heap. The height of the box refers to the 2017 TPS 3R Technical Guidelines, which is 1.3 m. Taking into account the land requirements and aesthetic factors when preparing the area, adjustments were made to the length and width of the boxes.

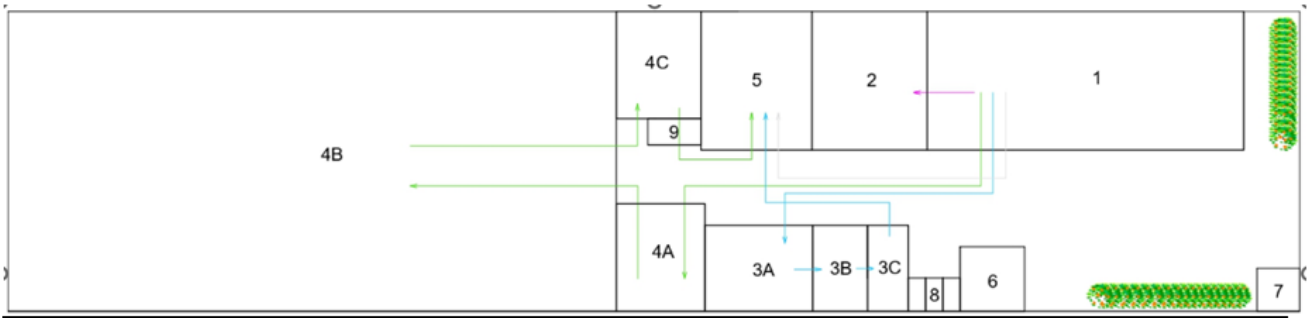
Organic waste that has become compost will shrink by 50% (Yuwono in Wahyudin & Nurhidayatullah, 2018). The compost will go through a sieving process to separate mature compost from contaminants that may still be present in unsorted compost during the sorting process and also to produce fine compost (Wahyono & Sahwan, 2010). There will be 2 officers in this area who carry out the process of sifting and packaging the compost.The selection of the right sieving machine is based on the weight of the compost to be sifted per hour. Screening is planned to be carried out for 3 hours per day. The weight of compost to be sieved per hour is 308.169 kg/hour. Based on Light Machine (2018), it is known that a sieving machine that can be used to sieve compost of 308.169 kg/hour is a machine with a capacity of 200-400 kg/hour

8. Area of Plastic Waste Processing

Plastic waste will first enter the washing process which is carried out by 1 officer. Washing is done to clean plastic waste from dirt that can interfere with the enumeration process (Aprilia, 2018). Plastic waste that has been washed will be dried conventionally using sunlight. After the plastic waste is dry, the waste will be chopped using a chopping machine which will be carried out by 1 officer. The choice of a chopper with these specifications is done by adjusting the weight of the plastic waste to be chopped and the capacity of the chopper. The weight of plastic waste to be chopped is 58.005 kg/hour, so a chopping machine with the smallest chopping capacity is chosen, which is 100 kg/hour. The plastic pieces will be packed by 1 officer before being taken to the storage warehouse.

9. Supporting Building

In this 3R TPS, apart from having waste sorting, storage and processing areas, there will also be other buildings that support waste processing activities. The buildings include warehouses for ready-to-sell goods, offices, toilets, guard posts, and leachate storage tanks. The warehouse area will be designed to store compost, chopped plastic, metal waste, paper waste and glass waste which are marketable. Then, an office is also provided which is used for administrative records related to processing activities at TPS 3R and a guard post used to support the security of TPS 3R. In addition to the warehouse, toilet, office and guard post areas, there is also a leachate storage area. This leachate storage tank is planned to accommodate leachate originating from the composting process. It is known that the water content of urban waste without any processing is 60% and the water content of mature compost is 13.06% (Sahwan, 2010). This tub is planned to use a septic tank with a detention time of 7 days and the design criteria refer to SNI 03-2398-2002 concerning Procedures for Planning a Septic Tank with an Infiltration System. The layout of TPS 3R can be seen in Figure 1.



1. Separation Area
2. Residue Storage Area
3. A. Plastic Waste Washing Area
   B. Plastic Waste Dewatering Area

3C. Crushing area
4A. Organic Waste Crushing area
4B. Composting area
4C. Compost Sieving and packing area

5. Warehouse
6. Office
7. Guardhouse
8. Toilet
9. Leachate Collection Basin

Green Line: Flow of organic waste processing

Blue Line: Flow Plastic waste processing

Yellow Line: Paper waste storage

Grey Line: Metal and Glass waste storage

Pink Line: Flow of Residue Storage

Figure 2. The Layout of TPS 3R Selapajang Jaya Sub-District

10. Cost Estimation

After designing the TPS 3R building, calculations are then carried out on the Draft Budget (RAB) to estimate the amount of costs required if this design is implemented. This RAB calculation refers to the 2018 Tangerang City Unit Price Standard, SNI for Analysis of 2017-2018 Work Unit Prices, and other data needed. The TPS 3R RAB calculation takes into account the construction and procurement of the equipment used in the 3R TPS. The investment costs required for the construction of TPS 3R in Selapajang Jaya Village is 434 million IDR include preliminary work, organic waste processing work, plastic waste processing work, support building work, and residue and separation work. With operational and maintenance costs of 45 million IDR, TPS 3R Selapajang Jaya is able to generate sales of 94 million IDR from the sale of 22,188 tons of solid compost (22 million IDR), 9,744 tons of crushing plastic (68 million IDR), 224.8 kg of scrap metal (823 thousand IDR), paper and 3,389 tons of used cardboard (2.3 million IDR), and 1,049 tons of used glass (524 thousand IDR). Thus, the establishment of TPS 3R is able to provide profit to managers which can be used to increase people's income (Suryawan & Lee, 2023).

Conclusion

The design of TPS 3R in Selapajang Jaya Sub-district will be carried out in accordance with the 2017 TPS 3R Technical Guidelines issued by the Ministry of Public Works and Public Housing. TPS 3R is designed on an area of 837.98 m2 and is also designed to serve around 1,952 households with a waste generation of 22,449 m3/day. TPS 3R will have a waste sorting area, a residue storage area, a plastic waste processing area, an organic waste processing area, warehouses, offices, toilets and a guard post. Waste that enters TPS 3R will be sorted into 5 (five) types of waste, namely organic waste, plastic waste, paper waste, metal waste and glass waste. Paper, metal and glass waste will be directly stored in the warehouse, while organic waste and plastic waste will go into the processing process. Organic waste will be processed into compost using the hollow brick box method, while plastic waste will be processed using a chopping machine to produce chopped plastic. Later, the processed and sorted products will be sold and the results will be used for TPS 3R operations in the future. Based on material balance calculations, processing at TPS 3R can reduce waste by 61.17%. The TPS 3R design requires an investment cost of IDR 434,370,815 with operational and maintenance costs per month of IDR 45,781,470. The estimated income earned by TPS 3R from the sale of processed and segregated products is IDR 94,148,061 per month.

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