Regional Case Study

Improving Recycled Waste Management Performance in Ngaliyan District, Semarang City

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Abstract

The waste that enters the Jatibarang landfills does not go through the management and processing process in advance, and the people's laziness in sorting waste has resulted in an increase in waste at the Jatibarang landfills. Ngaliyan reduce, reuse, recycle (3R) waste management site is currently inactive due to a lack of implementation in aspects of waste management. Therefore, it is necessary to plan waste management as an effort to overcome urban waste by increasing performance at reduce, reuse, recycle (3R) waste management sites. Data collection methods used are sampling, interviews, and questionnaires. In this technical, operational planning of waste management, an area of reduce, reuse, recycle (3R) waste management site is required of 661 m². Organic waste is processed through composting using the Open Windrow method, and inorganic waste is managed using the MRF (material recovery facility) method. The total cost required is IDR 11,135,856,300.00. The community is expected to be able to participate in waste processing and management through 3R-based sorting, comply with applicable regulations, and pay a retribution every month.

Keywords: Jatibarang landfills; composting; recycling

1.   Introduction

Waste is the residue from human activities in solid form. The amount of waste that continues to increase is directly proportional to the increase in population and activities each year. The presence of waste in the environment can cause various problems in the form of aesthetics, disease vectors, odours, dust, water pollution, fire hazards, and floods (Damanhuri, 2010). It is necessary to do sound processing so as not to harm the environment and public health. Based on Law Number 18 of 2008 concerning Waste Management Article 1 paragraph 2, management is a systematic, comprehensive, and sustainable activity that includes waste reduction and handling. Management is needed to support the waste reduction target carried out by the Presidential Regulation of the Republic of Indonesia Number 97 of 2017 concerning National Policy and Strategy (Jakstranas) for the Management of Household Waste and Similar Household Waste by 2025. To support the waste reduction target, it is necessary to construct an Integrated Waste Processing Site (IWPS) and a Reuse, Reduce, and Recycle Temporary Waste Storage (3R TWS).

The procurement of 3R TWS is one of the government programs carried out to reduce the number of waste produced by the community which will be disposed of in the landfill. However, the community in waste management does not yet have good awareness. That can be seen from the 3R TWS, which is poorly managed. The 3R TWS is the result of community self-help. Still, in implementing the 3R TWS, the community was inactive in utilizing the 3R TWS to manage the waste system. The lack of public knowledge about the 3R TWS, laziness in sorting waste, and the 3R TWS not receiving special assistance and attention from the local government caused the management system to fail. The solid waste at TPS 3R, Ngaliyan District, is not yet optimal. There is an increase in waste that goes into the Jatibarang landfill. Waste management in Semarang City only moves waste from the source to the Jatibarang landfill without taking advantage of the waste. Organic waste can be used as compost that is useful for plants, while inorganic waste is used through a recycling process.

The city of Semarang has 16 sub-districts, one of which is the Ngaliyan District which consists of 10 villages with an area of 37.99 km², a population of 139,338 people and a population density of 4,281 people/km2 with a population growth rate of 8.75% in 2015-2018 (Central Bureau of Statistics Semarang City, 2019). One of the waste processing efforts is the 3R system (reduce, reuse, recycle). Besides being able to reduce waste generation, 3R TWS can extend the life of the landfill. 3R TWS is where collection, sorting, reuse, and recycling activities are carried out on an area scale (Permen PU No.3, 2013). The number of 3R TWS in Ngaliyan District is 3 in Ngaliyan Village, Wonosari Village, and Tambakaji Village. The technical requirements for a 3R TWS are regulated in Permen PU No. 3 of 2013, where a 3R TWS has an area greater than 200 m2, while the 3R TWS in Ngaliyan District does not meet the existing technical requirements. Therefore, optimizing the 3R TWS to serve the waste in the Ngaliyan District properly.

2.   Methods

This final project was conducted in Ngaliyan District, Semarang City. The implementation starts from February 20, 2022, to June 20, 2022. Overall, in the implementation of this final project, there are four stages: literature study, proposal preparation, data collection and sampling, and report preparation. Data collection was carried out by several methods, namely sampling, filling out questionnaires, and interviews. The data needed in this study consisted of primary and secondary data. The sampling method of data collection was carried out by taking waste samples from the housing and non-residential sectors in Ngaliyan Village. The housing sector consists of permanent houses, semi-permanent houses, and non-permanent houses. The non-residential sector consists of shops, offices, schools, and markets. The questionnaire method was carried out by distributing several questions related to solid waste in Ngaliyan Village. The interview method was done by asking several questions to the UPTD of the Semarang City Environment Service and the manager of the 3R TWS in Ngaliyan District.

3.   Result and Discussion

3.1   Existing Condition Analysis

Analysis of the existing condition of solid waste in the District of Ngaliyan was conducted to find out what problems have occurred in the operation of solid waste in the District. The operational and technical aspects include service areas, storage systems, collection systems, transportation systems, and final processing systems. Several waste problems related to operational and technical aspects in Ngaliyan District, such as the coverage of waste services that do not reach the entire Ngaliyan District, the number of facilities and infrastructure is inadequate, efforts to reduce waste from the source are still minimal, and waste reduction capacity at TWS is minimal. In addition to problems based on operational and technical aspects, from the aspect of financing and retribution, there are several problems such as funds for

retribution which are still low so that waste management costs are still a burden on the Regional Revenue and Expenditure Budget (APBD), the allocation of financing for the waste sector is still below 5% that the amount the tariff is not by the operational needs of waste management.

3.2 Waste Generation and Population Analysis

3.2.1 Population Projection

The calculation of the projected population is carried out in the next ten years to illustrate the amount of waste generation. In projecting the population, several methods are used, including the arithmetic, geometric, and least square (exponential) methods. Of the three methods, the most appropriate method to project the population is to obtain a regression value (R) of 1, which refers to population growth over the previous five years. The most appropriate method to use is the arithmetic method.

3.2.2 Waste Generation Projection

As the population increases, it is directly proportional to the amount of waste generated. Waste generation can experience changes during the planning period, which will be influenced by the population growth rate and the planning area's development. Increased waste generation can be considered when planning a 3R waste management site. Therefore, it is necessary to calculate the projected waste generation for the next ten years at the rate of population growth and regional development. To determine the amount of waste generated in the District of Ngaliyan using the sampling method. Sampling to be carried out is guided by SNI-3964-1994 concerning Methods of Collection and Measurement of Generated Samples and Composition of Urban Waste. The waste generated comes from domestic waste and non-domestic waste. The amount of domestic waste produced is 0.24 L/person/day, and non-domestic waste is 0.055 L/person/day. Then a projection of waste generation is carried out for the next ten years that domestic and non-domestic waste in 2031 will reach 45,84 m^3/day.

3.3 Selection of 3R TWS Locations in Ngaliyan District

Based on the 2020 3R TWS Technical Guidebook, the success of the 3R TWS planning related to site selection is achieved if the criteria are met. These criteria include general criteria and supporting criteria. In planning, two locations will be used as land for planning 3R TWS. The locations chosen for the planning of the 3R TWS are Ngaliyan and Wates Villages. Then the location is determined using the scoring method.

3.3.1 Selected Location 3R TWS Ngaliyan

At the scoring stage, an assessment was carried out that adapted the 3R TWS Technical Guidelines published by the Director-General of Human Settlements (2017). This assessment assesses the feasibility of a location-based on 2 (two) main variables, namely, the level of community participation and environmental actualization (waste management). Each variable has 5 (five) assessment indicators, each with four criteria with different values ranging from four to one. This feasibility assessment has a high level of community participation variable with an assessment weight of 60 and lowers the current waste handling condition parameter with a value of 40. Details on the parameters considered in the 3R TWS location selection assessment can be seen in the appendix. After the assessment, it was found that the candidate for the 3R TWS location selected with a higher score was the candidate for the location I, which was located in Ngaliyan Village. Table 1 is the final assessment of 2 (two) candidate sites for 3R TWS Ngaliyan construction and the selected candidate locations for 3R TWS Ngaliyan in Figure 1.

Table 1 Results of Assessment of Candidates for 3R TWS Ngaliyan Location

	Candidate Location	Estimated Area (Ha)	Final Value
1	Ngaliyan Village	1.24	77.5
2	Wates Village	2.65	65

Figure 1 Candidate location of 3R TWS Ngaliyan

3.4 Waste Recovery Value and Loading Rate

The value of waste recovery is determined based on the generation and composition of the generated waste that enters the waste processing system to determine the processing process will be carried out and predict the amount of waste that will become residue and the amount of waste that will be left in the planning of 3R TWS. In planning the 3R TWS in 2031, the waste generation to be managed is 45,84 m3/day. In the planning of 3R TWS, the operational time is 6 hours, starting from 08.00 WIB - 12.00 WIB, then continuing at 13.00 WIB - 15.00 WIB (break at 12.00 WIB - 13.00 WIB). To get the amount of capacity of waste that can be processed at 3R TWSevery hour using the following calculation:

$$Loading\ Rate = \frac{Waste\ Volume\ (\frac{m3}{day})}{Operational\ Time\ (\frac{hour}{day})}$$

$$= \frac{45.84\ m3/day}{6\ hour/day)}$$

$$= 7.6\ m^3/hour$$

3.5 Waste Management and Processing Unit at TPS 3R, Ngaliyan District

Based on the 2020 3R TWS Technical Guidelines, the waste treatment system at the 3R TWS is divided into three options, namely option 1 (standard processing system), option 2 (standard processing system to improve the processing of stall waste), and option 3 (standard processing system for improved processing stall waste).

3.5.1 Means of Transportation

Waste transportation to 3R TWS uses a three-wheeled vehicle or three-wheeled motorcycle with a capacity of 2,1 m³. Three-wheeled motors are used to transport waste from residential waste-producing sources. Waste that enters the 3R TWS Ngaliyan District is still mixed between organic and inorganic waste.

3.5.2   Organic Waste Management Unit or Area

The organic waste management unit in 3R TWS Ngaliyan District has several stages with separate areas consisting of storage, enumeration, composting, and sieving/packaging areas. Organic waste is processed by composting. The method used in composting is using the Open Windrow system.

3.5.3   Plastic Waste Management Unit or Area

The plastic waste management unit in 3R TWS Ngaliyan District consists of a storage room, sorting, and enumeration. The facilities used in plastic management are chopping machines and press machines.

### 3.5.4   Inorganic Waste Management Unit or Area

The inorganic waste management unit at 3R TWS Ngaliyan consists of a storage room or shelter and sorting. Inorganic waste that has been transported by motor three is then put into the storage room for waste sorting. Inorganic waste in the form of paper, glass, and metal. Waste that is suitable for sale will be sold directly to the owner of the stalls, and waste that is not suitable for sale will become residue and be directly disposed of at the Jatibarang landfill. Inorganic waste is managed using the Material Recovery Facility (MRF) system.

3.6   Recapitulation of 3R TWS Area Ngaliyan

In determining an area of 3R TWS, the reference is to the per cent of the area stated in the Regulation of the Minister of Public Works Number 13 of 2013 concerning Provisions for the Placement of 3R TWS. Based on this reference, a standard 3R TWS area is calculated based on the number of households served.

Table 2 Land area requirement for 3R TWS

	Area	Land Requirement	Dimension
1	MRF Building	91 m²	10 m x 9.1 m x 4 m
2	Composting Houses	95 m²	10 m x 9.5 m x 4 m
3	Residue Warehouse	16 m²	4 m x 14 m x 4 m
4	Guard Posts	4 m²	2 m x 2 m x 4 m
5	Offices	16 m²	4 m x 4 m x 4 m
6	Toilets	3 m²	2 m x 1,5 m x 4 m
7	Vehicle Parking	45 m²	7,5 m x 6 m
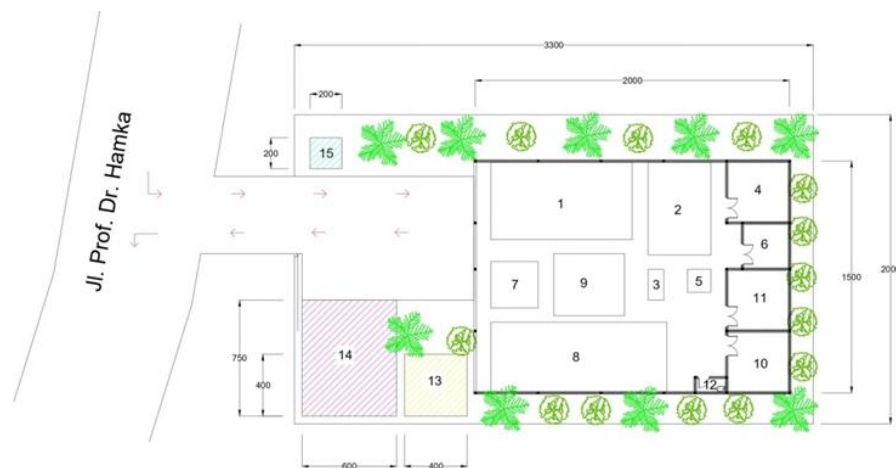
Figure 2 3R TWS Ngaliyan Siteplan

Information:

1   : Waste Receiving and Sorting Area
2   : Washing and Drying Area
3   : Press Area
4   : Waste Warehouse
5   : Area
6   : Tool Warehouse
7   : Enumeration Area
8   : Composting Area
9   : Screening and Packing Area
10   : Compost Warehouse
11   : Residue Warehouse
12   : Toilet
13   : Office
14   : Parking Area
15   : Guard Post

3.7   Supporting Facilities for 3R TWS in Ngaliyan District

The planned support facilities at 3R TWS Ngaliyan function to support all activities in 3R TWS. The planned support facilities include toilets, offices, parking areas, and guard posts.

3.8   Recapitulation of RAB Planning for 3R TWSin Ngaliyan District

The budget plan for 3R TWS in Ngaliyan District consists of investment costs for basic equipment, supporting equipment, and operational and maintenance costs. The investment costs for basic equipment include the construction costs of the 3R TWS infrastructure, the cost of connection for clean water and electricity, and the cost of basic equipment with a total of Rp 1,637,488,887.00. Investment costs for supporting equipment include equipment used to support the operational activities of 3R TWS Ngaliyan with a total of Rp. 13,274,800.00. 3R TWS Ngaliyan incurs operational and maintenance costs in all equipment operational activities and maintenance with a total of Rp 9,368,468,562.00. Then the total RAB obtained is Rp. 11,135,856,300.00.

4.   Conclusion

From the results of planning to improve the performance of 3R TWS Ngaliyan, it can be concluded that 3R TWS Ngaliyan is located at Jalan Ngaliyan 234 RW III Ngaliyan Village, Ngaliyan District. Currently, 3R TWS Ngaliyan is inactive. 3R TWS Ngaliyan manages and processes organic waste using the composting method while processing inorganic waste using a waste bank and making handicrafts. The results of the planning to improve the performance of 3R TWS Ngaliyan are as follows operational. The technical aspect is that the planning for the 3R TWS Ngaliyan was carried out in RW III, Ngaliyan Village, Ngaliyan District, with an area of 660 m2 consisting of the MRF building composting house, residue storage warehouse, office, toilet, and guard post. The 3R TWS Ngaliyan has compost fertilizer production with a weight of 2,097.2 kg/day and inorganic waste ready for recycling at 22.67 m^3/day. Financing aspect 3R TWS Ngaliyan spent Rp. 11,135,856,300.00, which consisted of investment in basic equipment of Rp. 1,473,869,704.00, investment in supporting equipment of Rp. 13,274,800.00, staff salaries of Rp. 7,161,264,000.00, and operational and maintenance costs of Rp.9,368,468,600.00. Income of Rp. 15,884,646,700,000. The institutional aspect of the management structure of 3R TWS Ngaliyan KSM was rearranged, and the vision and mission were reformed by the role of the 3R TWS Ngaliyan KSM plan. Legal and regulatory aspects

Procurement of Standard Operating Procedures (SOP) regarding waste management and processing at 3R TWS Ngaliyan, as well as issuing circulars from Ngaliyan District. Aspects of community participation, activities focus on improving 3R culture in the community and promoting the contents of circulars.

Acknowledgement

References

Alibaba., 2021. Industrial transport conveyor belt rubber belt conveyor China.

Alibaba., 2021. Portable gold trommel/sand screen for gold mining in China.

Alibaba., 2021. RYCD series suspended overband magnetic separator magnet for metal separation.

Badan Pusat Statistik Kecamatan Ngaliyan., 2019. Statistik Kecamatan Ngaliyan dalam angka 2019.

Badan Pusat Statistik Kota Semarang., 2019. Kota Semarang dalam angka 2019.

Czajcynska, D., Anguilano L., Ghazal H., Krzyzynska R., Reynolds A.J., Spencer N., Jouhara H., 2017. Potential of pyrolisis processes in the waste management sector. Thermal Science and Engineering Progress 3, 171-197.

Damanhuri, E., Padmi, T., 2010. Pengelolaan sampah. Diktat Kuliah Teknik Lingkungan Institut Teknologi Bandung 3104, 5-10.

Damanhuri, E., Padmi, T., 2016. Pengelolaan sampah terpadu. Institut Teknologi Bandung Press 2016, 41-44.

Darmasetiawan, M., 2004. Sampah dan sistem pengelolaannya. Jakarta: Ekamitra Engineering.

Direktorat Jenderal Cipta Karya., 2017. Petunjuk teknis 3R TWS tempat pengolahan sampah 3R. Jakarta: Kementerian Pekerjaan Umum dan Perumahan Rakyat.

Dortmans, B.M., Diener S., Verstappen B.M., Zurbrugg, C., 2017. Black soldier fly biowaste processing: a step-by-step guide. Switzerland: Swiss Federal Institute of Aquatic Science and Technology.

Kementerian Lingkungan Hidup., 2008. Undang-Undang Republik Indonesia nomor 18 tahun 2008 tentang pengelolaan sampah.

Kementerian Pekerjaan Umum., 2013. Permen PUPR RI nomor 3 tahun 2013 tentang penyelenggaraan prasarana dan sarana persampahan dalam penanganan sampah rumah tangga dan sampah sejenis rumah tangga. Jakarta: Kementerian Pekerjaan Umum dan Perumahan Rakyat.

Kencana Online., 2021. Mesin pencacah organik MPO 850 honda.

Kencana Online., 2021. Mesin press hidrolik MPH 6T elektrik.

Mulyani, H., 2014. Buku ajar kajian teori dan aplikasi optimasi perencanaan model pengomposan. CV. Trans Info Media, Jakarta.

Peraturan Menteri PU Nomor 3 Tahun 2013., 2013. Penyelenggaraan prasarana dan sarana persampahan dalam penanganan sampah rumah tangga dan sampah sejenis sampah rumah tangga.

Rachmawati, Q., Herumurti, W., 2015. Pengolahan sampah secara pitolisis dengan variasi rasio komposisi sampah dan jenis plastik. Jurnal Teknik Institut Teknologi Sepuluh Nopember 4 (1), 27–29.

Republik Indonesia., 2017. Peraturan pemerintah Republik Indonesia nomor 97 tahun 2017 tentang kebijakan dan strategi nasional (Jakstranas) pengelolaan sampah rumah tangga dan sampah sejenis rumah tangga.

SNI 19-2452-2002., 2002. Tata cara teknik operasional sampah perkotaan.

SNI 19-3242-2008., 2002. Pengelolaan sampah di pemukiman. Badan Standarisasi Nasional, Jakarta.

SNI 19-3964-1994., 2002. Metode pengambilan dan pengukuran contoh timbulan dan komposisi sampah perkotaan. Badan Penelitian dan Pengembangan Kementerian Pekerjaan Umum, Jakarta.

Statistik Daerah Kecamatan Ngaliyan., 2020. Statistik Kecamatan Ngaliyan dalam angka 2020.

Sugiyono., 2011. Metode penelitian kuantitatif, kualitatif, dan R dan D. Afebeta, Bandung

Sugiyono., 2015. Metode penelitian pendidikan pendekatan kuantitatif, kualitatif, dan R dan D. Afebeta, Bandung.

Tchobanoglous, G., Theisen H., Vigil S., 1993. Integrated solid waste management engineering principles and management issues. McGraw-Hill Inc Singapore, 949.

Wicaksono, M.A., Arijanto, A., 2017. Pengolahan sampah plastik jenis pet (polyethilene perepthalathe) menggunakan metode pirolisis menjadi bahan bakar alternatif. Jurnal Teknik Mesin 5 (1), 9–15.