An overview of the waste management system in Tembalang District, Semarang City

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Abstract. It is necessary to observe and evaluate the performance of the authorized institutions, in particular, related to the sub-unit of the Environmental Agency which manages the technical aspects (UPTD) and the five aspects of waste management to achieve better service to the people of Tembalang District. The UPTD is responsible for technical operations, including transporting domestic waste using arm roll and dump trucks, managing the cost budget plan, and supervising waste collection at the waste collection site. Tembalang District has a minimum waste generation of 156 m³/day with a generation rate of 0.814 l/person/day and a maximum of 216 m³/day with a generation rate of 1.217 l/person/day. The implementation of the five management aspects in Tembalang District still needs to be evaluated from the operational, technical, and community participation aspects. This situation is related to the segregation and sorting of waste that has not been carried out, independent processing that has not gone well, and activities at the landfill that are not suitable. The community participation, public awareness, and concern for waste problems are still low where the independent waste management through waste treatment facility partnerships and waste banks are possible to do.

1. Introduction
Waste is the residue of human daily activities and/or natural processes in solid form [1]. Meanwhile, waste management is a systematic, comprehensive and sustainable activity that includes waste reduction and handling [2]. Waste that is allowed to accumulate and rot on the street or around the house will cause unpleasant odors, interfere with environmental aesthetics, and become a nest for disease vectors so that it can reduce the level of quality of health and public welfare [2]. Proper waste management needs to be done so that waste does not become a vector of disease and does not cause disturbance to the environment [3]. The management of urban waste in Indonesia is carried out under the supervision and responsibility of the Environmental Agency [4].

Tembalang District became the study area based on being the sub-district with the largest population based on the BPS in 2019, which has 206,271 people in the area. The Semarang City Environmental Agency assigns the operational, technical responsibility for waste management to the UPTD (Regional Technical Implementation Unit) for Hygiene in implementing solid waste management. Waste
management is carried out based on five aspects: legal, institutional, technological, financial, and community participation [5]. Based on these matters, the purpose of this work was to make an overview of the management activities, primarily technical operations under the responsibility of the UPTD, and review the suitability of the five aspects of overall waste management in Tembalang District with the established standards.

2. Methodology
This work is carried out for 30 calendar days from July 16, 2020, to August 14, 2020. The data are obtained from direct observations of waste management activities in Tembalang District and interviews with UPTD officers. Meanwhile, some data was obtained through literature review documents of the Regional Cleanliness and Waste Management UPTD Region III and the Semarang City Environmental Agency.

3. Results and discussion
3.1. Overview of waste management in the district
The services provided by the Semarang City Environmental Agency related to operational technicalities are assigned to the Regional Technical Implementation Unit (Unit Pelayanan Teknis Daerah - UPTD), with the service area divided into four sub-districts. The UPTD carries out technical services in Tembalang District for Cleanliness and Waste Management Region III. The UPTD Region III has the authority related to operational technology with the following details to fulfill its duties.

a. Waste transportation at waste collection site using arm roll trucks
   UPTD Region III has 6 arm roll trucks used to transport waste from waste collection site to Landfill.

b. Waste transportation at waste collection site using dump trucks
   To assist the operation of arm roll trucks, especially in cleaning up the waste scattered at the waste collection site, UPTD Region III has 1 fleet of dump trucks. The field coordinator will report waste collection site that require more priority to be cleaned to the dump officer.

c. Waste transportation using non-waste collection site dump trucks
   Non-waste collection site dump trucks are used for transporting waste sources on the road. However, because the UPTD Region III only has 1 dump truck for Tembalang District, non-waste collection site dump truck operations in the Tembalang District Area cooperate with third parties.

d. RKA proposal procedure
   The RKA is a planning and budgeting document related to the need for costs used for spending on programs and activities by the UPTD.

e. Street sweeping
   Clean forces carry out road sweeping from the Rapid Action Force (Pasgat) from the Semarang City Environment Service (protocol road) and clean forces from third parties in collaboration with the Semarang City Environment Service (non-protocol). A third party carries out the road sweeping in Tembalang District because it is a non-protocol road.

f. Monitoring of waste collection from waste sources to waste collection site
   Sources of domestic and non-domestic waste in Tembalang District are accommodated in the nearest waste collection site before being disposed of to the landfill. Tembalang sub-district has 25 waste collection site, including non-service (self-help/private) waste collection site, where Rowosari Subdistrict does not yet have waste collection site.

3.2. Overview of the five aspects of waste management in Tembalang District
3.2.1. Legal aspect. Waste management in Semarang City, especially in Tembalang District, is carried out legally. Waste management is carried out based on applicable laws, starting from Law no. 18 of 2008, the regulation of SNI for solid waste, Permen PU No. 3 of 2013, until the Semarang City Regional
Regulation No. 6 of 2012 and Perwalkot Semarang No. 37 of 2015 as a guide to Regional Regulation No. 6 of 2012.

3.2.2. Institutional aspect. The institution authorized to handle and manage waste in Semarang is the Environmental Agency, which was established on the legal basis of Semarang Mayor Regulation No. 72 of 2016 concerning Position, Organizational Structure, Duties, and Functions, and Work Procedures of the Semarang City Environmental Agency.

Then to carry out tasks in the technical field, the Semarang City Environmental Agency is assisted by the UPTD for Cleanliness and Waste Management Region III, formed through the Semarang Mayor Regulation No. 77 of 2018.

3.2.3. Technological aspect. Tembalang District waste generation can be calculated through a calculation approach based on the size of the container at the waste collection site, which is a 6 m$^3$ container. Tembalang sub-district has 25 waste collection site and 36 containers, where the daily rhythm is different. From the analysis results, the minimum waste generation in Tembalang District is 156 m$^3$/day, and the maximum generation is 216 m$^3$. Then, the rate of waste generation can be calculated by dividing the waste generation per day by the total population, with population data that is known to be 191,672 people (has been reduced by Rowosari residents who are not served), and the minimum generation rate is 0.814 l/person/day, the maximum generation rate is 0.814 l/person/day 1,127 l/person/day.

Tembalang sub-district uses an individual housing pattern for the domestic sector, small offices such as government offices, and the Sendangmulyo Market. Meanwhile, the communal pattern is used in 3 other market sectors and hospitals. The suitability of the housing pattern to the existing provisions, namely SNI 19-2454-2002, the individual housing pattern of Tembalang District in terms of materials is appropriate. However, some have not been closed, and most have not been separated. Separated bins are only used in government offices, so the pattern of accommodation is not appropriate based on the provisions.

The pattern of waste collection used in Tembalang District is an indirect individual pattern and an indirect communal pattern. In the domestic sector, waste is first collected by a collector with 1 – 3 days, transferred to a waste collection site, and then transported to the landfill. Meanwhile, in the market/hospital sector, waste from each source is first transferred to communal containers (done every day) and then transported to the landfill. The suitability of the Tembalang District waste collection
pattern to the established standards is appropriate from the aspect of collection periodization but does not meet the waste separation aspect.

Before being transported to the landfill, Tembalang District uses a waste collection site per existing provisions. There are no waste collection site in Tembalang District, which have more than 200 m² of area. The existing condition of waste transportation in Tembalang District is quite different from the written waste collection site transportation schedule from the UPTD. This result is because of the many adjustments of the mobilization level and the truck driver's ability. Transportation that occurs in Tembalang District is carried out 3 to 5 times/day. The container has not been equipped with a leachate protective layer but has been closed using a net or the container cover.

Waste processing in Tembalang District relies on central processing at the Jatibarang landfill. This condition is because the independent processing has not been active in Tembalang District. Jatibarang landfill is a Semarang City landfill with waste processing technology in the form of utilizing methane gas into energy that can produce up to 300 kWh and waste reduction with BSF (Black Soldier Fly) technology with the ability to reduce waste to 300 kg/day. Jatibarang landfill is operated using Sanitary Landfill method with the final disposal of waste still mixed. Waste that has been disposed of leveled and stockpiled is covered with a tarp every day. It is also covered with soil every 5-7 days or when the waste has reached a height of 50 cm. Jatibarang Landfill has various facilities, including basic, environmental protection, facilities, and supporting facilities.

3.2.4. Financial aspect. As support in managing Tembalang District, there is a financial need by the management agency (Environmental Agency) through retribution from the community. The retribution is included the levy imposed on transportation waste from source to waste collection site and from waste collection site to landfill. The amount of retribution for transporting waste from the source to the waste collection site is determined by each region's respective neighborhood areas. A survey analysis was carried out on several residents of Tembalang District, and the results of transportation levies from sources to waste collection site varied, ranging from Rp. 10,000.00/month–Rp. 50,000.00/month. Meanwhile, transportation retribution from waste collection site to landfill is determined based on Perwalkot Semarang No. 18 of 2018 concerning Changes in Retribution Rates for Waste/Cleaning Services and Retribution for the Provision and Draining of Toilets. The collection of levies for transportation of waste collection site to landfill at Tembalang Sub-district houses on average has class V roads and class IV/III roads, which are Rp. 3,000.00 and Rp. 9,000.00.

3.2.5. Community aspect. The role of the community that is expected by the Environmental Agency in waste management in Tembalang District includes activities of sorting waste from the source, actively participating in paying waste management fees, actively participating in proposals/forums on the condition of the nearest waste collection site, being able to conduct intelligence on waste management towards waste management. Surrounding environment, and actively participate in waste management through waste treatment facility. From the results of the review and analysis of the participation of the Tembalang District community in waste management, the Table 1 illustrates the field conditions that occurred.

Tembalang District has a partnership in 2 waste treatment facility and 8 waste banks with existing conditions. Both waste treatment facility in Tembalang District are inactive, and 8 waste banks in Tembalang District are still active. Based on interviews, observations, and analysis, the Sri Rejeki waste bank is a sectoral waste bank at the neighbourhood level located on Jalan Baskoro RT 3 RW 7, Tembalang Village. Sri Rejeki Waste Bank was established in 2015. Activities in the Sri Rejeki waste bank are still in the form of buying and selling and administrative activities, including:

- Submission of inorganic waste (submitted at neighbourhood meeting)
- Weighing and recording
- Sales to collectors
- Utilization of money as a savings and loan cooperative
- Distribution of money and cooperative savings to customers every holiday
The facilities owned by the Sri Rejeki waste bank include land rental, scales, stationery, and waste storage inventory such as tables and cabinets.

**Table 1.** The form of community participation in Tembalang District in waste management.

| Community Involvement | Existing Condition |
|-----------------------|--------------------|
| Sorting waste from source | Not done yet, the waste is still mixed |
| Participate in payment of waste management retribution | The people are orderly paying the retribution |
| Actively participate in waste collection site aspiration forum | Actively complains about the condition of the TPS, but there is no solution, and participation in maintaining the cleanliness of the TPS is still lacking. |
| Participate actively in the intelligence of waste management | It has not been done. There are still many people who are not aware and care about the waste problem |
| Participate in the partnership of waste treatment facility and the waste bank | There are 2 waste treatment facilities and 8 waste banks in Tembalang District, but the waste treatment facilities are not active |

3.3. **Future research direction**

It seems that waste management system in Tembalang District are well-managed by the UPTD. However, Rowosari sub-district has not been covered by the waste management system. In this case, community-based solid waste management should be prepared to ensure there is no waste left behind and unmanaged. In Indonesia, *Rukun Warga* (RW)/Neighbourhood Association (NA) is part of the hierarchy of the smallest community organization system to currently incentivize creative and innovative solid waste management activities through a savings system [6]. Therefore, waste bank activities should be carried out at a minimum, on the NA scale, to ensure that the distance between the waste bank and its customers is not prohibitive [7]. Formation and management of central and regional waste bank can help control the selling price of each solid waste piece to control price fluctuations. Increasing the number of waste bank will increase the chances of creating more zero waste communities in the city [8]. More waste banks in the area are needed to reduce the burden on landfills and reduce national GHG emissions. Waste banks management quality also needs to be improved through training, coaching, and guidance from the government and industry [9].

4. **Conclusion**

Based on the results of the analysis that has been done, several conclusions can be drawn. The UPTD Region III is responsible for the operational, technical implementation of waste management in Tembalang District, including transportation of land/other waste using arm roll or dump, management of financial budget drafts, road sweeping, and monitoring of waste collection at waste collection site. Tembalang District has a minimum waste generation of 156 m$^3$/day and a maximum generation of 216 m$^3$/day, with a minimum generation rate of 0.814 l/person/day and a maximum generation rate of 1.217 l/person/day. Of the five aspects, Tembalang District has fulfilled the legal, institutional, and retribution aspects well. Meanwhile, several activities such as segregation in the container, collection, and transportation of waste, promotion of independent processing, and several activities in the landfill that are not by regulations need to be evaluated to improve waste management in terms of operational, technical aspects. Community awareness and mobilization, especially activities through waste treatment facilities partnerships and waste banks, need to be carried out so that community participation can increase waste management in Tembalang District. Suggestions that the author can give regarding waste management in Tembalang District as a consideration for the Semarang Mandiri City Environment Service are: sorting waste starting from the source/individual houses to reduce the mixing of waste, provide a separate container, provide input to the Environment Agency to start collecting, moving, and
transporting based on waste material, invite the community to develop existing solid waste partnerships jointly.

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