Assessment of domestic waste management in Demak Regency, Indonesia

Syafrudin\textsuperscript{1,2}, B S Ramadan\textsuperscript{1,2}, W D Nugraha\textsuperscript{1}, G Samudro\textsuperscript{1}, R Ardiana\textsuperscript{1}

\textsuperscript{1}Environmental Sustainability Research Group, Department of Environmental Engineering, Diponegoro University, Semarang Indonesia 50275
\textsuperscript{2}Department of Environmental Engineering, Diponegoro University, Semarang Indonesia 50275

syafrudin@lecturer.undip.ac.id

Abstract. Increasing the amount of waste generation is a problem in every city. This research aims to know the waste transportation and management system to analyze its compliance with the applicable national and local regulations in Indonesia. Demak Regency produced 208 kg/day of waste which this number represent 35.18\% of waste generated in Demak Regency from domestic and non domestic sector. The waste is transported and not sorted at sources, as the same with many other cities in Indonesia. Therefore, a proper waste management system is needed for Demak Regency that includes five aspects, which include technical, institutional, financial, regulation, and community aspects. The Environmental Agency of Demak Regency is the institution in charge of waste management in Demak Regency. The analysis shows that improvements are needed to achieve appropriate waste management system in Demak Regency. Therefore, efforts should be made to improve waste management in the Regency, for example, by improving technical performance, human resources, and promoting community-based waste management in the studied area.

1. Introduction
Population growth has triggered increasing waste generation, as this condition produce a serious problem in many cities, including Demak Regency [1,2]. In 2019, Demak Regency had a population of 1,158,772 people which are divided into 14 districts [3]. Therefore, appropriate waste management system must be developed for reducing more complex problems that can impact the health quality, public welfare and pollute the environment [4]. The technical issues of waste management system are divided into several concern including: storage, collection, transfer, transportation, processing, and final processing techniques [5]. The service areas of waste transportation at regency-scale is determined according to the function parameters and regional values, population density, existing service areas, environmental conditions; income level of the population; and topography [6]. The level of service is based on the number of residents served, the area, and the waste amount lifted to the landfill. Waste transportation carries waste from the waste collection site or directly from the waste source to the landfill site. The pattern of waste transportation can be made by direct individual method (door to door) and communal collection from the waste collection site [7].

Urban waste in Demak Regency comes from domestic and non-domestic waste (shopping centers, markets, and schools). This condition managed should spur the improvement of the quality of waste
management services in the Demak Regency. However, there are still many obstacles in implementing proper waste management system, including the lack of a waste collection site to serve all of the areas in the Demak Regency. Therefore, the waste community based solid waste management under waste bank helps the Environmental Agency of Demak Regency to minimize waste thrown into the landfill. Based on these backgrounds, this paper aims to assess the waste transportation and management system to be analyzed per the applicable regulations in Indonesia.

2. Methodology
This research was conducted by observing the existing condition of the Demak Regency solid waste management system. At the same time, the interview was done by asking the responsible officers about the waste management system in Demak Regency. Meanwhile, supporting literatures was obtained through analyzing the documents of the waste management division, Environmental Agency, Demak Regency.

3. Results and discussion
Demak Regency is divided into 14 districts where only a few districts are served by waste transportation system. The total area of Demak Regency is 897.43 km², while the area served by the waste collection site of the Sayung Area to the Kalikondang landfill is 17 km². The volume of Demak Regency’s domestic waste is predicted as much as 208 m³/day, while the volume of waste transported to the Kalikondang landfill is 73.173 m³/day. Based on the transported volume, the service level of the Environmental Agency is only 35.18%. Based on these data, the level of waste service in Demak Regency is not fulfilled the national regulation which targeting 75% of waste service level.

According to State Statistical Bureau of Demak Regency data, the population of Demak Regency is 1,158,772 people (in 2019) so that the waste generation rate per capita can be calculated as follows:

\[
\text{Waste generation rate} = \frac{\text{kg/day}}{\text{person}} = \frac{208 \times 1000 \text{kg/day}}{1,158,772 \text{ people}} = 0.2 \text{ kg/person/day}
\]

The waste generation rate per capita in Demak Regency is below the assumption applied, which is 3.25 l/person/day. The solid waste generated depends on various factors, such as economic activity, habits, population, and level of commercial or industrial activity. Many cities in Indonesia posing an enormous amount of solid waste, even reaching more than double the population growth rate. This phenomenon is significantly associated with rapid urbanization. The waste problem in regency is different comparing to metropolitan cities in Indonesia [14]. The waste generation is also lower than in metropolitan cities [1,7].

3.1 Household waste collection
Waste collection is carried out independently in each neighborhood where different capacities is found in each places [2]. This situation is evidenced by the waste generation at the Demak waste collection site as much as 24 m³/day which equipped with 3 containers. Besides, at the SMAN 2 Demak waste collection site, waste collected is found as much as 6 m³/day with 1 container. A hired-cleaning person who paid by the residents / community bring waste from the household to the nearest waste collection site using garbage carts. Sometimes, residents are also immediately dispose the waste to the nearest waste collection site without being sorted. In some conditions, especially where the household are near the landfill site, people using three-wheeled fleet and carts to bring and dispose the waste directly to the landfill site.
3.2 Transfer and transport of waste

The Environmental Agency of Demak Regency carries out waste service regarding the technical operations of transporting and managing waste from the waste collection site to the landfill. Meanwhile, waste management from the source to the waste transfer station is carried out by the neighborhood or the community itself. Communities collectively transfer their waste to the waste collection site by hiring cleaning person who usually use three-wheeled fleet or carts to transport their waste [2]. Arm-roll and dump trucks are used to transport the waste from waste collection sites to the landfill. Therefore, leaves and other waste from street cleaning are done by the Environmental Agency and transported from the waste collection site to the landfill [9]. The Environmental Agency has provided 25 waste collection sites spread across Demak Regency as communal containers. Each waste collection site consist of 1 to 3 containers. Therefore, there are 34 containers with a capacity of 8 m\(^3\).

The total capacity of existing containers in the Demak Regency is 272 m\(^3\). Thus, the need for additional containers can be calculated.

Waste collection container requirement
\[
= \frac{(\text{Number of production} \times \text{number of population} \times \text{number of days})}{1000} \\
= \frac{(0.2 \text{ L / person / day} \times 1,158,772 \text{ person} \times 1 \text{ day})}{1000} \\
= 238 \text{ m}^3
\]

Based on the calculations, 25 waste collection sites available in Demak Regency have only 272 m\(^3\) of the total capacity. This situation means that the existing waste collection sites cannot accommodate the total waste generated in Demak Regency. Therefore, it is necessary to add 5 more containers with a capacity of 8 m\(^3\). The pattern of waste transportation in the Demak Regency is a direct transportation system. Waste is collected at the nearest waste collection system and then large vehicles such as arm-roll trucks and dump trucks, will transport the waste directly to the Kalikondang landfill. Waste collection is carried out every Monday to Saturday. Waste collection site which has 2 containers occasionally wait the container is full before it is transported to the landfill. They are waiting the waste container full to reduce the cost of waste transportation. The figures 2 and 3 depict the transportation system used in Demak Regency.

There are 8 units arm-roll trucks (ART) available in Demak Regency which has good and proper condition. The dump trucks (DT) consists of 5 units which are also counted in good and proper condition. Containers or garbage bins that are ready to be transported all have lids, but some containers do not have covers, so they are required to cover them with nets for containers that are still open. In the operation of ART, the driver is assisted by 1 person to carry out the operation. While in the operation of the DT, the driver is assisted by 5 workers to carry out the operation. Each driver and crew is responsible for the operational vehicle for transporting the waste he carries.
3.3 Waste transportation route

The waste transportation does not have any technical issues regarding to the route of the truck from waste collection site to the landfill. The road on each route is enough for each truck to pass through. This situation happened in all waste transport station in Demak Regency.

3.4 Retribution

The waste management system in Demak Regency funded by the cleaning services retribution. Another source of funding is coming from regional expenditure budget (anggaran pendapatan belanja daerah – APBD). Retribution rates used in waste management and sanitation services in Demak Regency are based on Demak Regency Regional Regulation Number 4 of 2012 concerning Public Service Retribution. Based on the Demak Regency Regional Regulation, the households must pay the retribution of Rp. 500/month to 1500/month. This retribution are used as waste transportation from the waste collection site to landfill. Most residents do not want to pay dues because they do not put their waste to the waste collection site and they think that they have enough backyard to dispose their waste. Besides, people who are live in residential area should also pay for about Rp. 20,000/month for waste collection from their household to the household collection site.

3.5 Kalikondang and Candisari landfill

Waste management at the Kalikondang landfill is currently still operated using open dumping system, where the waste is only piled up and compacted without any daily cover. Kalikondang landfill has been operated from 07.30 – 14.00 WIB. While roads and gates to Kalikondang landfill are good, but the offices for staff are inadequate. Many gates around the waste pile are broken and gas pipes are no longer functioning. There is no weighbridge so the waste generation cannot be recorded. Waste is only an estimation of the total truck capacity. The leachate processing installation at the landfill has not operated for a long time, where the leachate is only collected without any further treatment. When it rains heavily, the leachate will overflow into the surrounding plantations or rice fields.

Kalikondang landfill will be closed in early 2021. Therefore, Demak Regency government has prepared a new landfill in Berahan Village, Wedung District, with a sanitary landfill system. The construction of this landfill has not been completed, so the temporary disposal is located in the Candisari landfill. Candisari landfill is also operated using open dumping system. Waste disposal in this landfill is not recorded, where the incoming trucks immediately disposes without recording. The infrastructure in this landfill has not been fulfilled where all the fences in landfills have not been made. There are no staff offices, leachate treatment installations, gas pipes, workshops. Landfill leachate often flows into
the rice fields, causing the rice field owners to suffer losses because the leachate contaminates the rice fields.

3.6 Waste bank and waste treatment site facility

Demak Regency has 91 waste banks actively manage inorganic waste in their environment. However, several waste banks are not running well due to inappropriate management system. Demak Regency also have 9 waste treatment site, but none of the 9 temporary waste transfer stations is active. Based on the results of a field survey at the Bango waste treatment site, which is located in Bango Village, Demak District, this treatment site only operated for 1 month in 2018. This situation was due to a lack of human resources and inconvenient waste management system. Besides that, the surrounding community had low self-awareness where people immediately put their waste into the collection system. The community does not do any sorting first, so the officers have to sort it out before processing it. Organic waste in this treatment site is converted into compost, while inorganic plastic waste is collected and collectors take the waste out from the facility.

4. Conclusion

Environmental agency of Demak Regency has been managed 25 waste collection site where the service level is reach 35.18% of the total waste generated in Demak Regency which is below the targets of a minimum waste service level of 75%. Moreover, some waste trucks have a shortage of the fleets and containers due to the large amount of waste that does not meet the availability of minimum containers. The waste containers and trucks should be added. Because the service level is low, there are still many illegal dumping founds on the roadside. The operational of Kalikondang landfill is not following the local and national government regulation. However, waste management through waste bank practices in the Demak Regency area has been going well. Those waste banks is potentially used as community based waste management which can reduce the number of waste in Demak Regency.

Acknowledgements

Faculty of Engineering, Universitas Diponegoro grants this study under Penelitian Strategis Fakultas Teknik Universitas Diponegoro number 195/UN7.5.3.2/HK/2021.

References

[1] Arikan E, Simits-Kalender Z T, and Vayvay Ö 2017 J Clean Prod 142 (1) 403–412
[2] Wibisono H, Firdausi F, and Kusuma E M 2020 IOP Conf Ser: Earth Environ Sci 447 012050
[3] State Statistical Bureau 2020 Demak District in number State Statistical Bureau Central Java
[4] Yang N, Zhang H, Shao L, Shao L M, Fan L, and He P J 2013 J. Environ Manag 129 510–521
[5] Sudibyo H, Majid A I, Pradana Y S, Budhijanto W, Deendarlianto and Budiman A 2017 Energy Procedia 105 263–269
[6] National Standards Agency. 2002. SNI 19-2452-2002 concerning Technical Procedures for Urban Waste Operations
[7] Pereira T D S and Fernandino G 2019 Ocean & Coastal Management 179
[8] Regulation of the Minister of Public Works of the Republic of Indonesia Number 21/PRT/M/2006 concerning National Policies and Strategies for the Development of Solid Waste Management Systems
[9] Suryadarma D, Poesoro A, Akhmadi, Budiyati S, Rosfadhila M, and Suryahadi A 2010 Food Policy 35 79–86