

# Evaluation of Waste Management in Piyungan Landfill, Bantul Regency, Yogyakarta, Indonesia

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**Abstract.** The municipal solid waste management system collects waste from the source to the final treatment site called landfill. The Yogyakarta Special Province has several landfills, one of which is Piyungan landfill, which serves three administrative areas, Yogyakarta City, Sleman and Bantul Regency. As a regional landfill, Piyungan has an area of 12.5 ha with 3 working zones, operationalized since 1995, estimated with the operational time 20 years. So that 2015 should landfill have been closed, but due to the degradation of waste until 2018 landfill is still used. Therefore, an evaluation mechanism is needed to show the existing condition in the field. Using the checklist method, using questionnaires and interviews and utilizing other secondary data. This method consists of five parts and has an assessment criteria in each component obtained assessment of facilities and infrastructure facilities of 2.25 (good category), while 1.68 for operational technical aspects (very good category). Overall Piyungan landfill evaluation scored 1.96 (good category). However, efforts are needed to ensure that the various facilities can be used properly so that the implementation and sustainability can work well.

## 1 Introduction

Statistical data presentation of Yogyakarta Special Province (DIY Province) shows that population growth rate of 2000-2010 in Yogyakarta increased by 1.04% [1], with the highest increase in Sleman Regency and the lowest in Yogyakarta City [2]. Population growth is proportional to the increase in the amount of waste, due to the various activities undertaken by humans. This rapid increase is incessant that in 2017, DIY Province has a potential waste production of 11,996 m<sup>3</sup>/day or 2,953 tons/day [3,4]. Given this disconcerting fact, it is necessary to balance the rapid growth of waste with good waste management in order to avoid damage and environmental pollution problems.

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The level of municipal waste service in DIY Province ranges from 7.49 to 85%, which shows a significant difference between one region and another due to many factors, such as geographical challenges of limited resources and funding [3, 5, 6]. Waste management towards the landfill (end of pipe concept) becomes a mainstay, even though it is not an effective solution. This concept has the potential to cause various problems related to technology and ends up with financing [3].

In 2013, 10 landfills in Indonesian's metropolitan cities only cover 10% of waste once a week, while others cover fortnightly (40%), once a month to once a year (50%). Similar conditions occur in 14 landfills in major cities of Indonesia, so that 58% of landfills are closed for a period of one month to once a year, even 14% of them do not close during operation. The condition is due to many factors, including the unavailability of land cover and high operational costs [7].

Waste management agencies in the region still consider landfill as the area of exposure alone, whereas if it refers to the Law 18/2018, landfills have been converted from disposal to processing waste by various methods. Thus, it is expected that the practice of open dumping can be minimized to improve the aesthetics of the city by way of creating landfills with good condition. These landfills not only function as a place to dump of municipal waste for the sake of the city's cleanliness. In the early 1990s, the transition method of controlled landfills was introduced by the Ministry of Public Works, especially for small and medium-sized cities. This transition method, among others, was done by way of delaying the criteria of daily covering time to 5-7 days in accordance with the fly cycle (disease vector). However, to date, the waste management of the city considers it as too costly [8].

Piyungan landfill covers the area of 12.5 Ha located in Sitimulyo Village, Piyungan Subdistrict, Bantul Regency, DIY Province of Indonesia, at about ±16 km southeast of Yogyakarta downtown. It has been operated since 1995 and serves three working areas, that is Yogyakarta City, Sleman and Bantul Regency. Meanwhile, two other areas, namely Kulonprogo and Gunungkidul Regency have a landfill in their respective administrative areas [3,9]. This study aims to evaluate the suitability level of waste management in Piyungan landfill in terms of technical and operational aspects based on the checklist method as an evaluation method of waste management in landfill. Based on the results of risk identification and analysis, there are four environmental components posing a high risk in the management of Piyungan landfill: air pollution, groundwater, surface water and decreasing environmental esthetics brought about by gas, leachate, leakage on soil, and bad odors [10].

Piyungan landfill began its operation in 1995, which is projected to last for 15 to 20 years. It should have ended its operation in 2015, but until 2016 the landfill is still operated by optimizing zone 1 that has been previously closed/full. However, this operation is predicted to last only for 1-2 years. Thus, at least in 2017, the Government of DIY Province must have a development plan from the new landfill to accommodate the incessant growth of waste [9]. An evaluation of technical and operational aspects is required in order to achieve better waste management.

## **2 Research methodology**

The study begins with collecting landfill-related references, studying and evaluating the references, preparing survey completion, primary and secondary data collection, data analysis, conclusions and recommendations. On this basis, the researcher created a questionnaire using the checklist method for conducting survey. The study was conducted from February to May 2018 at the Piyungan landfill, Bantul, Yogyakarta. This checklist method consists of 82 components divided into 5 parts; (1) basic and supporting facilities,

(2) main facilities, (3) management and monitoring of landfill, (4) maintenance of landfill, and (5) environmental monitoring.

The checklist method is a qualitative and quantitative method used to assess the existing condition in the landfill. Furthermore, the criteria are described in numerical form so as to facilitate analysis and make conclusions from number 1 (highest) to 5 (lowest) for each assessment component. Data analysis was done descriptively to find criteria according to the checklist method for primary data collection and for calculating an average value from each aspect studied. After that, the researcher measured the average resulted criterion and compared it with the existing criteria to draw conclusion.

Assessment criteria in the checklist method consists of five parts, two parts are related to aspects of infrastructure facilities, while the other three parts are related to operational aspects. Aspects of infrastructure include basic and support facilities in a landfill, while operational technical aspects include the management and monitoring of landfill, maintenance and environmental monitoring.

The basic and supporting facilities of the landfill consist of 18 assessment components, including road access, security posts, fences, parking lots, environmental drainage, office, clean water facilities, electricity, equipment warehouse, garage equipment, workshops, vehicle washers, canteen, worker rest areas, laboratories, and buffer zones.

The main facility of landfill consists of 22 assessment components, including landfill cells, waterproof coating, gravel layer, leachate collection channel, leachate treatment plant, gas pipeline installation, monitoring/testing well, leachate sample equipment, weighbridge, scales recorder, composter buildings, composter equipment, cover soil area, garbage truck, maneuvering area, cover soil, bulldozers, excavators, compactors, embankment and embankment protection channels.

Assessment of landfill facilities and infrastructure is classified into 2 categories, the level of availability and conditions. The availability category consists of 5 criteria:

- The first criterion is completeness; if facilities are available in full completeness and are qualified in construction.
- The second criterion is sufficiency; if the existing facilities are sufficiently geometric, but the construction is still not eligible.
- The third criterion is lackness; if facilities are available, but neither geometric nor construction are eligible.
- The fourth criterion is non-existence; unavailability of facilities.

The category of condition assessment also consists of 5 criteria:

- The first criterion is goodness; if the facility as a whole is in maximum condition.
- The second criterion is feasibility; if part of the construction of the condition is damaged, but not to interfere with its utilization.
- The third criterion is damaged; if most construction conditions are damaged and may disrupt their utilization.
- The fourth criterion is heavily damaged; if most of the construction is damaged and can not be utilized.
- The fifth criterion is the absence of condition data of the facility.

Assessment of operational technical aspects for landfill consists of 2 categories, implementation and sustainability. Category assessment of the implementation consists of 4 criteria:

- The first criterion is completeness; if the operation is done in its entirety.
- The second criterion is sufficiency; if the operation is almost completely done leaving a small part undone <25%.
- The third criterion is less; if most of the operation is still not done, > 25% is not done.

- The fourth criterion is non-existence; if it is not operated.

Sustainability assessment category consists of 4 criteria, namely:

- The first criterion is routinity; if operational continuity is done continuously (routine).
- The second criterion is rarity; if operational sustainability is still small and less-than-regular (<25% not routine).
- The third criterion is rarity; if operational sustainability is still largely incomplete (> 25% incomplete).
- The fourth criterion is never; if it is not operated sustainably.

### 3 Results and Discussion

Piyungan landfill is a regional landfill with waste from urban areas of Yogyakarta City (53%), Sleman (34%) and Bantul Regency (13%). With a storage capacity of 2.7 million- $m^3$ , each day it can accommodate up to 450-500 tons of waste, with 200 ritations/day [3, 11]. The total area of 12.5 Ha, is divided into 3 zones, with details of each 3 Ha for zone 1 and 2, 4 Ha for zone 3 and 2.5 ha are used as supporting facilities for landfill operations such as offices, workshops, weighbridges, leachate treatment, road access and buffer zone.

High soil components are derived from the degradation of organic waste, based on data of waste composition entering Piyungan landfill dominated by organic waste, in the form of food, garden waste (64.41-68.52%), plastic, glass and metal (0.56-11.19%), fabrics (3.49%), wood (3.24-6.11%) and paper (2.08-10.24%) [3, 12, 13]. With the composition of high organic waste, it is very possible that the resulting soil is also high, besides the soil is derived from the soil cover used in operational of landfill [9,14].

#### 3.1 Basic facilities and supporting Piyungan landfill

The road infrastructure at Piyungan landfill consists of road access, operational and connecting roads. Road access connects landfill with protocol road. The operational road for the waste transport vehicle to the point of discharge of waste. Meanwhile, a connecting road connects between parts in the landfill area. Broadly speaking, existing roads are built with concrete construction. However, it has suffered a lot of damage. The available parking lot is not too big, at about  $100m^2$ . In case there are too many waste trucks, the queue may reach the road towards the landfill.

Drainage in the landfill serves to drain the runoff of rainwater to minimize the flow of water into the pile of waste. The drainage is in poor condition because it is covered by wild plants. In addition, this allows the mixing of leachate water with rainwater.

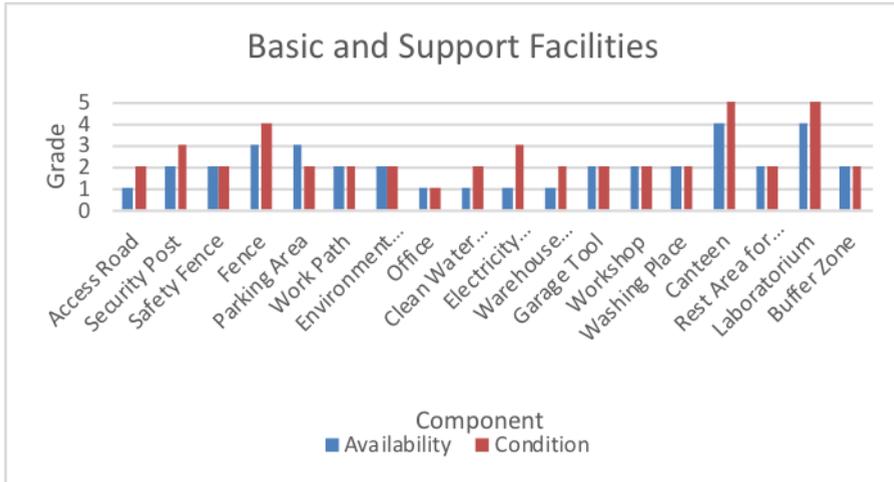
Clean water and electricity facilities at Piyungan landfill are provided by each local agency. Clean water is used for office and washing machine needs as well as other landfill facilities. The provision of clean water in Piyungan landfill uses tanker truck from PDAM. Meanwhile, the electricity at Piyungan landfill uses electricity from PLN.

Warehouses, garages, and workshops are the supporting facilities that must be available in the landfill. The facility serves to store and/or repair lightly damaged equipment. The warehouse covers an area of  $120 m^2$  and can accommodate landfill operational equipment. The garage measures  $160 m^2$  and can accommodate three to four heavy equipments. The workshop measures  $40 m^2$  and can only accommodate one machine that has been slightly damaged. However, the garage and workshop are full of equipments and damaged parts of the machine.

Other basic facilities are security post, office, gate, and car wash. The security post functions well, but it is lack of human resources leads to the unification of postal and

weighing stations as a place to take care of trucks. The office of the Piyungan landfill is well maintained, while the car wash is categorized as feasible because it does not interfere with its utilization. This landfill, however, only has one gate.

The buffer zone serves to reduce the negative impacts caused by the waste disposal activity to the surrounding environment. This buffer zone is a green line or hedge around the landfill. The buffer zone in Piyungan landfill covers an area of 1000 m<sup>2</sup> using Angsana varieties.



**Fig. 1.** Assessment of basic and support facilities in Piyungan landfill

### 3.2 Main Facilities of Piyungan landfill

One cell in the Piyungan landfill is used to accommodate the waste for 3 to 7 days. The availability of cells in this landfill is pretty much less because of the lack of land to accommodate the waste, while the condition is largely damaged, thus disrupting its utilization. The waste cells used today are cell 1 and 2 in zone 1 and 3. The height of waste in zone 1 and 3 is up to 30 to 40 meters.

Waterproof coatings and gravel layers are the basic layers used so that leachate does not seep into the soil and does not contaminate groundwater. Waterproof layer used is a geomembrane layer with an area of 5000 m<sup>2</sup>, while the length of the gravel layer is 2000 m long.

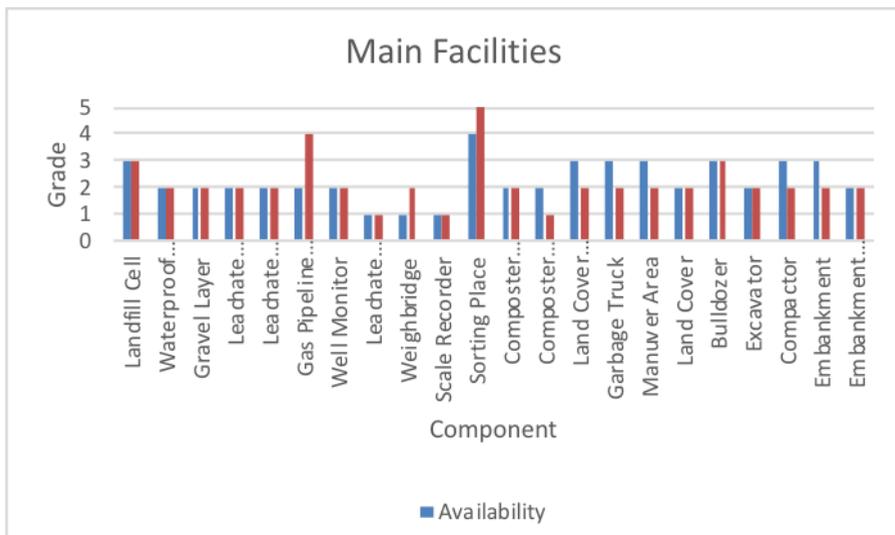
Weighbridges and compactors are included in the complete criteria for availability and are feasible for conditions. Meanwhile, leachate collection channels, embankment protection channels, leachate treatment plants, test wells, composter buildings, cover soils, and excavators are classified as sufficient criteria for availability and feasibility of conditions.

The leachate collector channel is a horizontal pipeline along the 1200m to drain leachate from the waste pile to the leachate treatment plant. The embankment protection channel has a length of 1200 m in the Piyungan landfill and serves to protect the embankment from rainwater flow. The function of the leachate treatment plant is to treat leachate from waste piles for further discharge to water bodies in safer conditions or in accordance with permitted leachate disposal regulations. The test well serves to monitor the possible pollution resulted from the Piyungan landfill operation. Of the six test wells, some of the water from the well is consumed, while others are used for bathroom and laundry activities. Leachate treatment is done in seven ponds. Two pools serve as a filter and filter basin. The

other three pools serve as an aeration pool, maturation, and disinfection, while the last two ponds are utilized to extend the dew time of the treated water.

To optimize the processing of organic waste, Piyungan landfill is equipped with composting building, which serves to process organic waste into compost. There are two units of excavators in this landfill which serve to dig the ground to close the landfill cell. Closing the land with the aim of closing landfill cells is done if the shortest period has been met. Soil cover is available around the landfill but it is usually provided through a third party. Generally, rock soil taken from Bawuran, Pleret is used to cover the landfill. The availability of land cover at Piyungan landfill is 5000 m<sup>3</sup>.

Ground cover, maneuvering, compactor, and embankment areas are categorized as less available and eligible for conditions. The place where the cover covers serves as a place to put the covering ground; the area of the maneuver serve as a place to move and accelerate the garbage truck to the landfill; and safety dikes to protect the landfill area from surrounding conditions. The compactor that is in proper condition for use is only one unit. Meanwhile, bulldozers are categorized as less available and are in damaged condition because there are five bulldozers and none are ready to use.



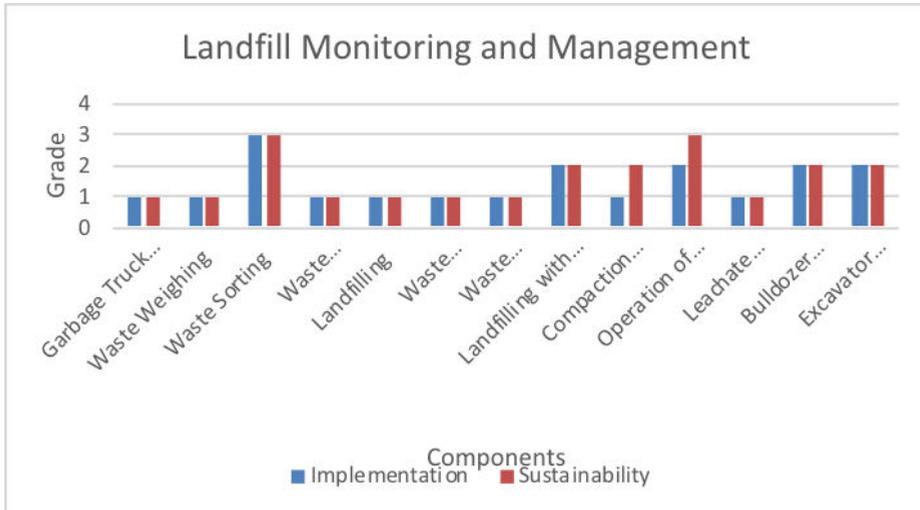
**Fig. 2.** Assessment of main facilities in Piyungan landfill

### 3.3 Management and monitoring of Piyungan landfill

Landfill management and monitoring include several components, namely recording of incoming trucks, waste weighing, waste segregation, waste reduction, landfill, garbage leveling, solid compaction, land cover, soil compaction cover, gas pipeline operations, leachate processing, bulldozer operations, and excavators. Most aspects of landfill management and monitoring are included in the sufficient categories for implementation and routine for sustainability.

Management and monitoring through recording, weighing, degradation, stockpiling, smoothing, and solidification of waste include the complete category for implementation and routine for its sustainability. Operations occurring at weigh stations are the recording and weighing of incoming trucks, the dismantling of the specified cell waste, the separation of waste by the scavengers, and the distribution of waste by heavy equipment so that the garbage truck can get out of the landfill. The incoming truck recording is done by recording

the date, vehicle registration certificate, vehicle type, origin, driver's name, time of entry, and garbage weight.



**Fig. 3.** Assessment of monitoring and management in Piyungan landfill

The management and monitoring of the landfill are carried out on the operation of the gas pipeline, leachate treatment, bulldozer and excavator operation. Monitoring and management of gas pipeline operations are not implemented very routinely. This monitoring is conducted to avoid explosions in gas vents due to increasing pressure by waste piles. Leachate monitoring is done routinely every three months. This is to determine whether or not the quality of leachate processes water that flows into water bodies.

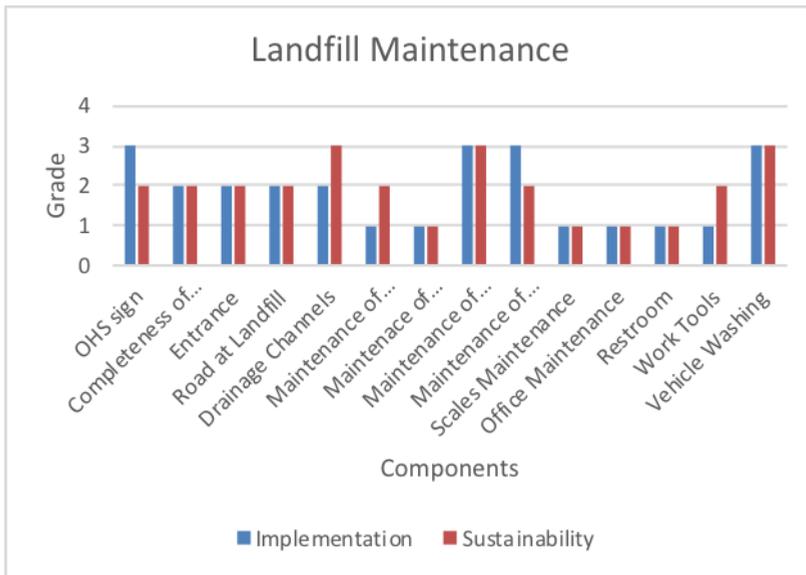
Meanwhile, waste selection management is only conducted to 5% of garbage. Selection of waste is done by scavengers only for saleable goods. This sale is usually a bottle and plastic. Incoming waste amounts to 150 trucks each day, meaning that there are about 7 to 8 trucks that are the result of waste sorting.

### 3.4 Maintenance of Piyungan landfill

Maintenance of the landfill includes several components including safety signs, completeness of health and safety facilities, road access, roads in a landfill, drainage channels, IPL maintenance, compost maintenance, garbage truck maintenance, heavy equipment maintenance, scales maintenance, office maintenance, bathroom maintenance, equipment maintenance, and vehicle washing. Most aspects of landfill maintenance are categorized as adequate for implementation and rare for sustainability.

Maintenance of compost sites, maintenance weighbridge, office maintenance, and maintenance of the bathroom is classified as complete for implementation and routine for its sustainability. Maintenance of compost sites is done by checking the tools and places used to support the composting process. Composting is done by way of open windrow technique with periodical frequency reversal. Compost from this technique is usually ready to be packed for sale after experiencing the maturation process of compost for 30 days or one month. Maintenance of the scales is done with calibration every year. Calibration is done to make the scales remain accurate. In addition, the office is maintained by daily cleaning before and after office hours. Likewise, the bathroom is maintained by weekly cleaning.

Meanwhile, maintenance of leachate treatment plants and work equipment is classified as a complete category for implementation and rare for sustainability. The maintenance of the leachate treatment plant is done differently depending on the condition of the unit. The sediment pond is cleaned once every three months, the aeration pond is cleaned once every six months, and the pool for an extended stay is cleaned every month alternately. Meanwhile, maintenance of work equipment is done when the work equipment has been damaged and disrupt the function of the tool. If the work equipment is damaged, but does not interfere with its function then has not done maintenance.



**Fig. 4.** Assessment of landfill maintenance in Piyungan landfill

### 3.5 Environmental monitoring

Environmental monitoring includes several components, namely leachate monitoring, air quality, slope stability, construction of buildings in landfill, waste collection, environmental drainage, scavengers, local community concerns, social conflicts, monitoring of flora and fauna, monitoring of surface water and groundwater quality, monitoring of garbage odors, public unrest, and customer satisfaction. Most aspects of environmental monitoring are included in the category sufficient for implementation and routine for sustainability.

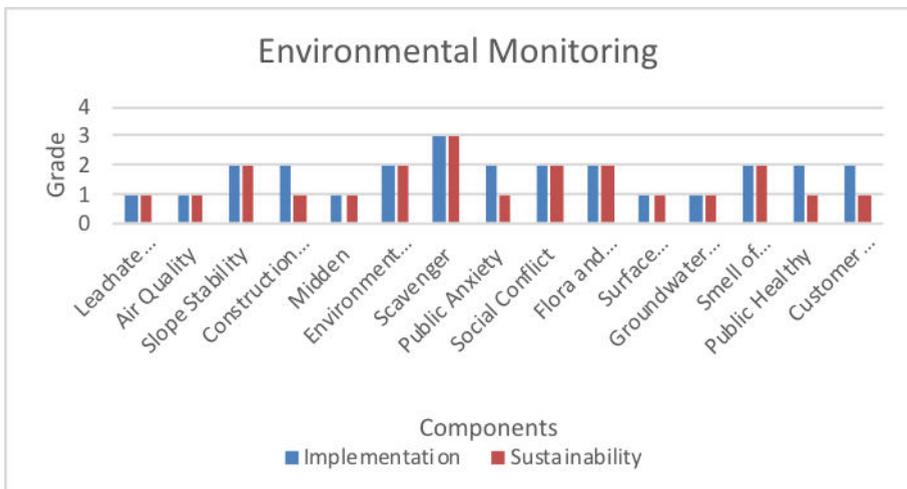
Leachate monitoring, air quality, waste heap, surrounding community unrest, surface water quality, and groundwater quality is classified as complete and routine for implementation and sustainability. Leachate monitoring is conducted monthly by the Settlement and Balai Pengujian Infrastruktur Permukiman dan Bangunan dan Pengembangan Jasa Konstruksi (BPIPBPJK). Air quality monitoring is conducted once in three months by UGM in cooperation with Balai PISAMP. Monitoring of groundwater and ground water quality is done once every three months.

Furthermore, monitoring of anxiety, health, and customer satisfaction is done twice a year. Monitoring of social conflicts is rare for sustainability. Within 1 year, there are 2 periods of free medical examination for scavengers and residents around the landfill. In addition, at the end of the year, there is a budget for the physical construction (public facilities) of the affected area of the Piyungan landfill (amounting to as many as 11 Neighborhood wards).

Monitoring of building construction is carried out to ensure the level of safety of the construction of the building. In addition, safe building construction will facilitate the monitoring of other aspects that are critical to the sustainability of the Piyungan landfill. Meanwhile, the monitoring of slope stability is carried out by a technical team of Balai PISAMP.

Monitoring of environmental drainage, social conflict, flora-fauna, and a odor of waste is classified as sufficient for implementation and rarely for sustainability. Monitoring is carried out but remedial action is only taken when there are urgent problems, such as blockage of environmental drainage resulting in floods, social conflicts with people, the death of flora and fauna around the Piyungan landfill, as well as the strong odor of garbage that stings and disrupts the health of the citizens.

Meanwhile, scavenger monitoring is categorized as less for implementation and rarely for sustainability. This is because scavengers are components outside the landfill that come because of individual or group initiatives. The number of waste pickers in the Piyungan landfill has reached 450 people.



**Fig. 5.** Assessment of environmental monitoring in Piyungan landfill

This method classifies the 5th scale conversion checklist into a qualitative value. Value conversion aims to facilitate assessment of the evaluations that have been made.

**Table 1.** Assessment criteria

Average Score	Description
$x \leq 1,8$	Very good
$2,6 < x < 1,8$	Good
$3,4 < x < 2,6$	Enough
$4 < x < 3,4$	Less
$x \geq 4$	Very less

Based on the recapitulation which leads to the sum of each aspect value, the researcher calculated the average value. Basic and supporting facilities resulted in the amount of value equal to 82 to 36 component which is equal to 2,28 from scale 1 (highest) to 4 (lowest). The main facility amounts to 98 to 44 components which obtains an average of 2.23 from the

scale of 1 to 4. Management and monitoring aspects of the landfill resulted in the values of 40 to 26 components which equals to an average of 1.54 of scale 1 to 4. Landfill maintenance aspects resulted in the values of 53 to 28 components which is equal to an average of 1.89 from a scale of 1 to 4. In addition, the environmental monitoring aspect resulted in the values of 50 to 30 components which is equal to an average of 1.60 from a scale of 1 to 4.

## 4 Conclusion

It is concluded that the facilities and infrastructure available in this landfill are categorized as average with the value of 2.25 and is classified as good. Meanwhile, operational and technical aspects resulted in an average value of 1.68 and are classified as excellent. The overall average value for the evaluation of Piyungan landfill is 1.96 and is categorized as good. However, it is recommended that the government reconsider the provision and condition of facilities and infrastructure so as to support operational activities at the Piyungan landfill. The technical and operational aspects of the Piyungan landfill must be adjusted to the applicable SOPs, to improve the implementation and sustainability.

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