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Medical Waste Management of Public Health Center (Puskesmas) in Bogor City

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Abstract: Bogor City has 25 Puskesmas with each medical waste generation can be up around 100kg/month. The temporary storage activity requires proper treatment and management complying with regulation Ministry of Health No.56 (2015) and Ministry of Environmental and Forestry No.6 (2021). The study aims to analyze basic problem of medical waste temporary storage activity of Puskesmas in Bogor City. Qualitative approach with observation and depth-interview had been done with related parties. Analytical Hierarchy Process (AHP) is done to analyze most interested mitigation. Result shows that remaining from total population: 36% needs to provide proper medical waste temporary storage, 24% waste cold storage, 36% wastewater treatment plant (WWTP). Main obstacles found includes limited land, procedural weaknesses, and internalization of other costs. AHP is done to overcome the weakness of limited land, with three alternatives (providing additional space in the current location; providing communal hazardous waste temporary storage; providing licensed offtaker). The scoring result sequentially 14.8%, 16.3%, and 68.9%. Basically medical waste management by Puskesmas in Bogor City is in continous improvement in order to comply with the regulations. More attention need to be put on WWTP to avoid pollution especially to groundwater quality which none attention had been made so far.

Keywords: AHP; Medical waste; Puskesmas; WWTP

Introduction

Basically, all human activities will generate waste either liquid, gases, or solid waste. It needs to be managed properly to avoid environmental pollution and health problem (Hanipah, 2020; Rosyidah, 2018). Medical waste generation is linier with human population and the needs of health services. Medical wastes are waste materials produced from health service facilities, including hospitals, clinics, doctor's offices, dental clinics, blood banks and veterinary clinics, as well as from medical research facilities and laboratories (Ekawaty et al., 2022; Wulandari et al., 2023).

Based on Government Regulation No. 22 Year 2021/Appendix IX, medical wastes are classified as hazardous waste including residue from processing facilities/incinerators and from wastewater treatment plant/WWTP. Medical waste in hospitals and health care facilities is categorized as hazard level 1 for waste code A and 2 for waste code B. Codes and types of waste for hospitals and health care facilities include A337-1 (infectious clinical waste), A337-2 (expired pharmaceutical products) , A337-3 (expired chemicals), A337-4 (laboratory equipment contaminated with B3), A337-5 (medical equipment containing heavy metals), B337-1 (used pharmaceutical product packaging), B337-2 (WWTP sludge), A347 -1 (incinerator fly ash), A347-2 (slag or incinerator bottom ash), B347-1 emissions treatment residue), B347-2 (used filters and absorbents), B347-3 (WWTP sludge) (Nastiti, 2022; Purwanti, 2018; Saputro et al., 2022).

The treatment and management have to comply with Ministry of Health No. 56 Year 2015 and Ministry of Environmental and Forestry No. 6 Year 2021. Even though medical waste generation smaller (around 20%), comparing to the domestic wastes generation, its characteristic especially infectious can become a source of rapid disease transmission, especially for the workers

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who are in direct contact regularly. Potential impact caused by miss medical waste management including environmental pollution especially from the WWTP, air pollution from incineration, uncontrolled infectious disease distribution from the solid waste (Wicaksono et al., 2023).

During the Covid-19 pandemic in Indonesia (2020-2022), medical waste generation increased by 30% in Jakarta, 6 times in Wuhan City, China, 10% in Malaysia, 2 times in West Sumatra Province (Yolarita et al., 2020). In Indonesia, according to the Ministry of Health, before the Covid-19 pandemic occurred, there was already gap 70 ton/day medical wastes processing capacity all around Indonesia. There was also lack of licensed transporter especially for remote areas in Indonesia.

Research conducted by Atthar et al. (2022), at a hospital in Jakarta, showed an increase of almost 8 times during the Covid-19 pandemic. Additional types of B3 medical waste from this pandemic period include used personal protective equipment (PPE) such as masks, gloves, face shields, body protectors, eating and drinking utensils from Covid-19 patients and from rapid test activities related to Covid-19 detection. Swab test or swab test and vaccination (Kemekes Republik Indonesia, 2020; Susanto et al., 2023).

Management of medical waste includes reducing and sorting, storing, transporting, processing, burrying, and landfilling (Kasdjono, E, Bachtiar, A, Oktamianti, P, Sipahutar, 2022; Purwanti, 2018; Ronald et al., 2019; Welliana et al., 2022). Distribution of licensed processing facilities (incineration) and transport services is uneven, even in the eastern region, Malupu and Papua, there is no medical waste processors. Limited medical waste facilities can cause high costs for transporting medical B3 waste from producers to lisenced processing facilities. Example of medical waste transportation and processing cost in West Sumatra is around IDR 17.000-23.000/kg (Yolarita et al., 2020).

Illegal dumping of medical waste has found in environmental media such as on roadsides, water bodies, domestic waste landfills, open area like bushes, mangrove, seas, and other illegal places in various cities in Indonesia. Illegal treatement or management such as manual burning can cause law and administrative punishment to the leader of the health facilities. Ombudsman (2021) noted that there are at least 138 million tonnes of medical wastes that are not managed properly yet.

Puskesmas is a health service facility that organizes public health and individual health efforts at the first level (Ramadhan et al., 2021; Umardiono et al., 2019; Zaini et al., 2022). Puskesmas tend to prioritize promotive and preventive actions, however many of them also provide curative and rehabilitative actions (Ayuningtyas et al., 2018). Like a mini hospital, Puskesmas especially in city areas could also provide services 24 hour stand by service for emergency and birth, stand by ambulance and Emergency unit, laboratory analysis, rontgen, medical check up, teeth and mouth, mental treatment. According to Government Regulation No. 47 Year 2016 regarding Puskesmas, each sub-district (*Kecamatan*) in Indonesia is required to have at least 1 Puskesmas. Depend on the working areas, each Puskesmas can be supported by one or more second layer Puskesmas (*Pustu*). According to data from the Ministry of Health (2018), Puskesmas that has manage medical waste according to regulations are in the minority, around 6.89% (Kristanti et al., 2022).

Bogor City has land area of 11.850 hectares consisting of 6 sub-districts (North Bogor, East Bogor, South Bogor, West Bogor, Central Bogor and Tanah Sareal) with total 25 Puskesmas. Bogor City is a rapid developing and a capital supporting city with total population 820.707 people (2021) or population density 11.770 people/km^2 with the highest density in South Bogor District (5,019 people). Eighteen (18) of total 25 Puskesmas are non-inpatient (*nonrawat inap*) Puskesmas, and the others 7 are inpatient (*rawat inap*) Puskesmas.

Table 1. List of Puskesmas in Bogor City

Puskesmas	Type	Sub-District
Belong	non-inpatient	Central Bogor
Gang Aut	non-inpatient	Central Bogor
Bogor Tengah	non-inpatient	Central Bogor
Sempur	non-inpatient	Central Bogor
Merdeka	inpatient	Central Bogor
Bondongan	non-inpatient	South Bogor
Cipaku	inpatient	South Bogor
Lawang Gintung	non-inpatient	South Bogor
Bogor Selatan	non-inpatient	South Bogor
Mulyaharja	non-inpatient	South Bogor
Kedung Badak	non-inpatient	Tanah Sareal
Pondok Rumput	non-inpatient	Tanah Sareal
Mekarwangi	inpatient	Tanah Sareal
Tanah Sareal	inpatient	Tanah Sareal
Kayu Manis	non-inpatient	Tanah Sareal
Pulo Armyn	inpatient	East Bogor
Bogor Timur	non-inpatient	East Bogor
Pancasan	non-inpatient	West Bogor
Semplak	non-inpatient	West Bogor
Gang Kelor	non-inpatient	West Bogor
Sindang Barang	non-inpatient	West Bogor
Pasir Mulya	inpatient	West Bogor
Tegal Gundil	non-inpatient	North Bogor
Warung Jambu	non-inpatient	North Bogor
Bogor Utara	inpatient	North Bogor

Based on Minister of Environment and Forestry No. 56 of 2015 regarding Procedures and Technical Requirements for Management of Hazardous and Toxic Waste from Health Service Facilities, medical wastes

from health service facilities are divided based on characteristics: infectious; sharp; pathological; expired chemical waste, residue from spills, and used packaging; radioactive; pharmaceutical; cytotoxic; medical equipment containing high levels of heavy metals; waste gas cylinders or pressurized containers.

The time limit for storing medical waste by producers is maximum 2 days for infectious waste, sharp objects or pathological waste under room temperature. If a disinfection process is carried out, it can be stored for up to 90 days at a maximum temperature of 0^0C. For expired chemical waste, spills, contaminated packaging residue, radioactive, pharmaceutical, cytotoxic, medical equipment containing high heavy metals and pressure cylinders can be stored for a maximum of 90 days if the waste weighs more than 50 kg, and 180 days if the waste weighs less than 50 kg.

If the waste producers are not capable to do further treatment after temporary medical waste storing activities, they can make agreement with lisenced third parties. The liseced issued by Ministry of Environmental and Forestry and Ministry of Transportation for transportation activities and lisence from Ministry of Environment and Forestry for further treatment such as incineration and or landfilling activities.

Method

This research uses qualitative approach with method direct observation and *in-depth-interviews* with multi stakeholder to analyze various points of view. Time period of this research is around 3-4 months on site (August-November 2023). Mainly there are 3 population groups in this study, Puskesmas, government comprising of Health Department (Dinkes) and Environmental Department (DLH) of Bogor City, and related licensed medical waste transportation offtaker.

Inclusive criteria is used to determine respondent in each group as follow:

a) Puskesmas: a person in charge who have responsibility on the management of medical wastes and has capacity to discuss regarding human resources, waste costs, procedures, infrastructure and equipment. Basically this person is a *sanitarian/Kesehatan Lingkungan (Kesling)/Tenaga Sanitasi Lingkungan (TSL)* in each Puskesmas. Depend on working areas of each Puskesmas, at least one person is dedicated for this position. In addition, the day to day person who has direct contact with the medical waste is cleaning service. So this research also involved cleaning service as responden. Randomly about 2-3 cleaning services had been interviewed.
b) Government (Health Department and Environmental Department of Bogor City): a person in charge who have responsibility on direct supervision of medical wastes monitoring from Puskesmas. Basically this person is a *Kesehatan Lingkungan/Kesling* Section of Health Departmen (Kesling-Dinkes), and Hazardous Waste Section of Environmental Department (Limbah B3-DLH).
c) Lisenced medical wastes transportation vendor: a person in charge who have responsibility on direct supervision of medical waste transportation from Puskesmas. All Puskesmas in Bogor City use PT. Adipraya Hijau Lestari as their medical waste transportation vendor. This researched included interview with Marketing Department of PT Adipraya who also responsible for agreement between Puskesmas, Transporter PT. Adipraya Hijau Lestari and medical waste further processor PT PPLi located in Cileungsi, Bogor Regency.

All data and information is analyzed decriptively comparing with the applicable regulations and analyzed the root caused or main difficulty for the Puskesmas in complying the current medical waste regulation. Then, grouping and prioritizing the root caused obstacle. The most obstacle is discussed further with related parties especially the government (DLH and Dinkes of Bogor City) to analyze potential mitigation. Further scoring then be done by Analytical Hierarchy Process (AHP) on the most obstacle. AHP assessment is supported by AHP online software https://bpmsg.com/ahp accessed on 3rd November 2023.

Result and Discussion

In general, puskesmas financial resources are *Jaminan Kesehatan Nasional* (JKN), *Biaya Operasional Penyelenggaraan* (BOP), and *Biaya Operasional Kesehatan* (BOK). JKN is a health service program from the government *Badan Penyelenggara Jaminan Sosial* (BPJS) as national insurance. Depend on BPJS membership in each Puskesmas working area, higher number of participants will also make higher to the Puskesmas income, but linear with the patient visits and Puskesmas expenses such as for service fees and drugs. BOP and BOK are budgets provided by the local government through the *Anggaran Pendapatan dan Belanja Daerah* (APBD) for each Puskesmas based on their operational expenditure plans and health-related expenditure, also including salaries for temporary employees. Financial data of Year 2022 taken from 6 Puskesmas as described in the table 2.

In average, medical waste cost handling to lisenced third party is under 0.5% percent, so basically currently this is not burdening the Puskesmas budget. Based on the interview with Environmental Department of Bogor

City (DLH), "*in average, Puskesmas income is very small, and they are still supported by the local government, so our role in supervision tends to be coaching rather than providing sanctions*."

Table 2. Medical Waste Cost Handling Year 2022

Puskesmas	Budget (IDR)	Annual Medical Waste* (kg)	Cost (%)
Bogor Tengah	1.867.000.000	592	0.48
Merdeka	2.425.000.000	411	0.25
Bogor Timur	4.500.000.000	1.431	0.48
Sindang Barang	4.500.000.000	929	0.31
Tegal Gundil	2.553.000.000	727	0.43
Bogor Utara	4.500.000.000	411	0.14

Note: medical waste cost IDR 15.000/kg, applied to all agreement each Puskesmas with the vendor.

Applied to all Puskesmas in Bogor City, the medical waste is handed over to a licensed transporter PT Adipraya Hijau Lestari once per month. The transporter then directly deliver to the lisenced medical waste processor PT PPLi in Cileungsi Bogor Regency, about 30 km from Bogor City. In average, the transporter car can deliver up to from 7 Puskesmas in one day trip. All Puskesmas are required to have medical waste cold storage in their hazardous waste temporary storage *Tempat Penyimpanan Sementara* (TPS) room. The cold storage is especially for storing the infectious and pathogenic waste, because it exceeds the 2 days storing time duration. Puskesmas are also required to obtain documents or permits *Rincian Teknis* TPS for whom have *Upaya Pengelolaan dan Pemantauan Lingkungan* (UKL UPL), and *Berita Acara* (BA) from Dinas Lingkungan Hidup (DLH) for whom have *Surat Pernyataan Kesanggupan Pengelolaan dan Pemantauan Lingkungan* (SPPL).

Puskesmas activities under Minister of Environment and Forestry Regulation Number 4 of 2021 concerning List of Businesses and Requirements Have an Environmental Impact Analysis, Environmental Management Efforts and Environmental Monitoring Efforts or a Statement of Capability for Environmental Management and Monitoring, with number of Klasifikasi Baku Lapangan Usaha Indonesia (KBLI) number 86102 must obtain SPPL unless whom already obtain UKL UPL based on previous regulation.

The results of this research show that 24 out of a total of 25 Puskesmas in Bogor City have environmental documents (UKL UPL or SPPL). A total of 22 out of 25 health centers have TPS rooms, and 19 out of a total of 25 have medical waste cold storage, 5 Puskesmas already obtain TPS licensing documents, and 2 Puskesmas are in the application process to DLH. Apart from that, 8 Puskesmas already have wastewater treatment plant (WWTP), 1 already has the permit documents, and 5 are in the application process to DLH. In each interview session with the Puskesmas environmental health officer, they are generally related background study and have good understanding regarding the medical waste regulations.

However, based on the results of observations and interviews, it was found that environmental health officers do not directly come into contact with the medical waste regularly, but the garbage officers or cleaning officers do. From the results of random interviews with cleaning service officers, some of them had never attended training related to medical waste management, and did not know and understand the potential dangers of medical waste handling, so rarely use Personal Protection Equipment (PPE) while working. Apart from that, according to one of the cleaning officer, the delivery of medical waste from the medical waste bins in each room is not carried out every day, but is carried out when it is full. On another occasion, another cleaning officer did not know what is TPS medical waste and could not differentiate it from WWTP.

Based on the results of an interview with Hazardous Waste DLH staff, "*Before Covid-19, there was no reporting from each Puskesmas to DLH. Since 2021, the SIMPELA application has been implemented to monitor the generation of hazardous waste from Puskesmas. Waste handling cost of Covid-19 treatment (mid-2021-2022) in each Puskesmas is handled by DLH. Since the enactment of the hazardous waste TPS Rintek which is an obligation of the Undang-Undang Cipta Kerja (UUCK)/Job Creation Law, every Puskesmas is required to have a cold storage. UUCK also degrade the obligation for Puskesmas's environmental documents to SPPL with hazardous waste temporary storage permit is Berita Acara (BA). For Puskesmas who already have environmental documents in the form of UKL-UPL, the obligation to obtain Rintek TPS is still applies. Currently, a total of 16 Puskesmas already have hazardous waste permit Rintek TPS, 2 are in the process of Gang Aut and Tanah Sareal, while 7 others have not yet applied. The condition of the medical waste infrastructure and facilities at Puskesmas in Bogor City is better than some Puskesmas in Capital City Jakarta, because some Puskesmas in Jakarta do not have TPS room*."

Based on the results of field observations, the potential for environmental pollution from TPS is quite small because the type of medical waste is predominantly in solid form and has been packaged well. The liquid form comes from the radiology unit, with very small occurrences. Of all the Puskesmas visited, only the Central Bogor had a history of handing over radiological waste to licensed third parties. Meanwhile, based on random interviews, there were Puskesmas that did not know the history of radiological

waste disposal due to lack of communication and coordination between environmental health officers and radiology unit officers.

The higher potential environmental pollution was analyzed from the WWTP because all Puskesmas visited do conventional grounded WWTP which have potential for groundwater pollution from leakage. However, there are no Puskesmas who have groundwater wells and regular groundwater quality monitoring. Even though the majority of residents around the Puskesmas use water pipe from *Perusahaan Daerah Air Minum* (PDAM) Bogor City instead of groundwater, this still needs to be a concern. Six (6) data of WWTP outlet quality from Puskesmas are collected and analyzed (Merdeka, Tegal Gundil, Warung Jambu, Bogor Utara, Bogor Timur, Sindang Barang). None of the exceed the threshold limit as stated in Minister of Environment and Forestry Regulation No. 5 of 2014 Appendix XLVII. All of them do not have schedule or historical of sludge dredging. Meanwhile, the sludge is also categorized as hazardous waste, so it needs to be stored in the TPS.

However, from the results of observations, the majority of TPS conditions are too small and do not have a separator, making it difficult to add other types of waste especially sludge WWTP. Another alternative can be sludge suction vendor appointment, but current transportation vendor PT Adipraya Hijau Lestari do not have service for sludge sucking although it can handle sludge WWTP if it already been packaged. The sludge service also has not been found in the Puskesmas annual internal costing plan.

Figure 1. TPS Condition of Puskesmas Cipaku (left) and Puskesmas Tanah Sareal (right)

Apart from that, DLH requires outlet WWTP monitoring monthly, but due to cost consideration, mostly Puskesmas do 1-2 times outlet quality monitoring per year. Puskesmas Merdeka do monthly outlet WWTP monthly additional budget subsidize from Health Department Bogor City. None of outlet WWTP visited have outlet valve, so it is difficult for them to avoid surface water pollution from WWTP if in case of emergency. Here below emergency case (bad quality) of outlet unit.

Result shows that remaining from total population puskesmas Bogor City that 36% still needs to provide proper medical waste temporary storage, 24% still need to provide medical waste cold storage, and 36% still need to provide wastewater treatment plant (WWTP) to process the liquid medical waste.

Figure 2. Outlet Unit Condition (Case Emergency: Bad Outlet Quality)

From all the results of direct observations and interviews, there are 3 groups of obstacles with rank as follow:

Limited Land

Based on the Minister of Health No. 75 Year 2014 regarding *Pusat Kesehatan Masyarakat* (Puskesmas), Article 13, at a minimum the Puskesmas must have system infrastructure: ventilation, lighting, sanitation, electricity, communications, medical gas, lightning protection, fire protection, noise control, vertical transportation system for buildings with more than 1 floor, mobile health center vehicles, and ambulance vehicles. However, this regulation does not regulate the minimum building area compared to the area or service coverage. There are 3 type of Puskesmas: Urban, Rural, Remote-Very Remote.

All of Puskesmas in Bogor City are categorized as Urban Puskesmas. Unlikely Rural and Remote-Very Remote Puskesmas, Urban Puskesmasproblem usually at land availability. While Rural and Remote-Very Remote Puskesmas have problems with medical waste vendor availability. Urban Puskesmas also has difficulty complying with *Koefisien Daasar Bangunan* (KDB) 60% as required in the regulation.

The constraints of limited land are also related to limited area for TPS which ideally also can have separate capacity for storing other hazardous waste such as used

oil from generator, office hazardous waste, sludge WWTP, etc. Even at Puskesmas Lawang Gintung and Gang Aut, the cold storage cannot be put in the TPS because of their TPS size are too small. In all cases, there is no historical mass balance of medical waste from *Puskesmas Pembantu* (Pustu).

Procedural Weakness

Standard Operational Procedure (SOP) on medical waste management shall comply with the applicable regulations. It is also important to ensure that the implementation also be accessible and understood by the relevant parties. Procedural weaknesses can cause potential environmental pollution and health problems, especially for staff or patients and the surrounding resident. Procedural weaknesses found in this research includes:

a) Transportation of medical waste from Pustu to Puskesmas

Basically, Pustu is under the responsibility of the regional Puskesmas, including the medical waste. Medical waste generation from Pustu is quite small and mainly from activity of dental and mouth. The current condition is that the Pustu does not have related human resource and the medical waste facility or independent egreement with liseced third party, therefor all the resource is from each regional Puskesmas. The transportation for medical waste is not complying with the regulation and the medical waste transportation period from Pustu to TPS Puskesmas also not everyday, even not clearly written in the current available SOP. It causes potential mixing of medical waste and domestic waste and potential disposal to the domestic waste facilities.

b) Mixing medical and non-medical waste in waste bins in each room

Findings from direct observations in the field show that there is still a mixture of medical and non-medical B3 waste in the trash in the waste bins in the upstream (unit room). Waste sorting procedures is mainly responsibility of health employees such as doctors and nurses because they are the ones who do sorting and dispose into waste bins. So it would be best to strengthen outreach the sorting procedure to these parties.

c) Maintenance of WWTP

Among all Puskesmas, no history of WWTP sludge disposal to licensed third parties was found. Even though the sludge generation period depends on wastewater load and WWTP capacity, regular sludge service shall be done to maintain the WWTP effectiveness. The WWTP also requires Technical Approval permit from DLH which can help making sure required WWTP equipments are on place. Based on interview with Health Department Bogor City, "*Having WWTP is like nurturing living creature, we need to implement proper procedures including nurturing the bactery inside processing unit and periodically clorination on the outlet unit. Most current health environment staff at Puskesmas do not well understand how to manage the WWTP, therefor I have put budget for capacity building, so they can also consider the regular cost in managing the WWTP.*"

d) Use of Personal Protective Equipment/PPE for cleaning staff

Even though environmental health staff in all interview sessions understood the importance of PPE for cleaning staff, from direct observations and interviews with cleaning staff at Puskesmas, they rarely use PPE when working with waste. But at least they use masks, gloves and regular hand washing has been carried out. Re-strengthening of capacity and knowledge is encouraged, especially for cleaning staff.

Internalization of Other Cost

Significant missing internalization cost includes: monthly monitoring periods for IPAL outlets as per DLH's requirements, regular groundwater quality monitoring, and costs for handling other hazardous waste such as WWTP sludge, used generator oil, radiological waste, office hazardous waste, etc. Other aspects include PPE, disinfectant for medical waste, and maintenance of WWTP.

AHP assessment is done for the most obstacle which is limited land. The AHP assessment is in consultation with 3 key stakeholders from each population (Puskesmas, Health Department and Environmental Department Bogor City). Three alternative to overcome was decided: providing additional space/land in the current location; providing communal hazardous/medical waste temporary storage; providing licensed vendor/offtaker.

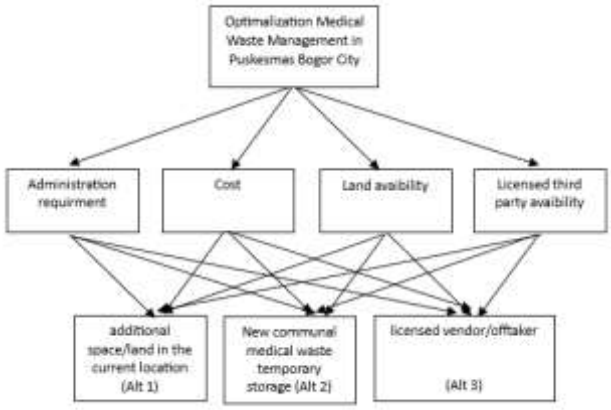

Figure 3. AHP Hierarchy

There are four (4) sub level or criteria of each alternatives: administration, cost, land availability, and lisenced third party/vendor availability. Administration including the change or additional permitting requirements. Cost related to new aspect of costing or higher current costing. Land availability including the land space and its ownership/land status. Licensed third party including the available lisenced vendor to overcome the different kind of medical waste and available on periodic medical waste transportation. Each of three alternatives have strenght and weakness as scored following:

Table 3. AHP Assessment

Criteria	1	2	3	4	Score
Alt 1	0.10	0.11	0.14	0.17	0.148
Alt 2	0.10	0.17	0.16	0.19	0.163
Alt 3	0.78	0.70	0.69	0.63	0.688
CR	0.002	0.055	0.005	0.009	(accepted)

Some of the challenges of each alternatives are as follows:

a) Providing additional space in the current location (Alt 1)

Expansion current land for most Puskesmas is a problem because the majority are located in densely populated locations or commercial areas where there is no longer any vacant land. Based on the results of interviews with DLH Bogor City, there are 3 Puskesmas that are currently planning to relocate or move to larger areas, Gang Aut, Lawang Gintung, and Kayu Manis. The realization is pending due to land status and aquisition problems.

b) Providing new communal medical waste temporary storage (Alt 2)

The construction of the new communal medical waste storage raises challenges related to the management/person in charge, provision of human resources/staff, cost providers, land availability, distance and access from each Puskesmas needed, as well as administration related to new environmental document and permittings.

c) Appoinment of lisenced vendor/offtaker (Alt 3)

Searching and appointing vendors has the lightest challenges, lisenced vendor availability, higher/more often of periodical medical waste handover and higher waste handover cost. However, most Puskesmas is located in an urban area and close to waste processing vendors, this challenge is low. Costing related can also be discussed and supported through BOP (*Biaya Operasional Penyelenggaraan*) which is supported by APBD (*Anggaran Pendapatan dan Belanja Daerah*).

Conclusion

All puskesmas in Bogor City do not have processing medical waste facilities, therefor all of them self storing on site then hand over to lisenced third party. Comparing to medical waste regulation, there are still remaining work including that 36% for proper medical waste temporary storage, 24% for medical waste cold storage, and 36% for WWTP. However, the management of medical waste from the Puskesmas in Bogor City already continuously strives to comply with the applicable regulations. There are 3 main obstacles including some Puskesmas faces difficulty of limited (available) land, mostly Puskesmas have procedural weaknesses, and not considering the internalization of other costs. AHP assessment result that appointing lisenced medical waste vendor for more often and for other kinds of medical waste such as WWTP sludge, is the most interesting with scoring 68% among other alternatives. The potential for environmental pollution and public health problems arise especially from WWTP operations and lack of usage PPE by cleaning staff. Sustainable development and financing are needed to achieve good and optimal environmental performance of Puskesmas.

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Author Contributions

Defi Darylianty Debora conceptualized research idea, methodology and data analysis. Dwi Nowo Martono and Fatmah give critical feedback and sustantial review.

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Conflicts of Interest

The authors declare no conflict of interest.

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