

Alternative medical waste treatment during COVID-19 case study in Hospital X Jakarta City

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ABSTRACT

Medical waste management in health care facilities is very important because medical waste has various health risks. One hospital can incur up to Rp 1 billion/year for medical waste treatment costs. This study aims to analyze the proper processing of medical waste in hospitals in Jakarta during the pandemic. This type of research is a descriptive observational study conducted cross-sectional through observations on solid waste management at Hospital X, Jakarta City. Decision analysis in this study uses the Analytical Hierarchy Process (AHP) method to support the medical waste treatment decision-making process. In this study, two processing methods are given, namely the incinerator and autoclave. An incinerator is a thermal process used to treat medical waste at controlled temperatures. An autoclave is a medical waste treatment that combines moisture, heat, and pressure to sterilize medical waste. The results of the AHP show that hospitals should optimize autoclaves to sterilize highly infectious waste, which can also be used to sterilize sharp medical waste. Meanwhile, medical waste treatment using incinerators can generate other waste in the form of ash from combustion residues. Ash from the combustion process can contain heavy metals such as Cr, Zn, and Pb. Therefore, a strategy is needed to deal with this waste generation so that the final treatment does not end in a landfill but can be a useful product.

Key word: medical waste; AHP; autoclave; incinerator; landfill.

INTRODUCTION

Medical waste management in health care facilities is very important because medical waste has various risks to health for anyone, including health workers, patients, and the community (Aung et al., 2019; Das et al., 2021; Septiariva et al., 2022). For example, the impact of medical waste with poor management on the environment, among others, the decline in environmental quality that can interfere and cause health problems for people living in the environment around health facilities and outside communities, the emergence of occupational health problems in the form of occupational diseases (Sari, Inoue, et al., 2022). This is caused by sharp medical waste, infectious or containing chemicals, such as being pierced by used/unsterile needles, high-risk factors for transmitting diseases such as Hepatitis B and HIV (Franka et al., 2009).

Medical waste generated from health service activities has a high potential for causing severe damage (S Khobragade, 2019). Injuries occur due to poor ways of sorting out the waste to be disposed of in the trash (Birkbeck, 1978). As a result, the medical waste can cause negative impacts on the surrounding environment (Atthar et al., 2022; Sari, Yosafaat, et al., 2022). The effect threatens patients and health workers, and visitors in the health facility environment. These incidents can occur due to inaccuracies in sorting the types of medical waste. For example, they can occur due to needle sticks because they are not put into the safety box. Accidents and the transmission of infections caused by medical waste to other health workers must separate medical waste at the beginning. Efficient medical waste management practices and personal protective equipment in the workplace can reduce adverse impacts on health workers (Sangkham, 2020).

Medical waste from these health facilities is in the form of sharp objects, such as used needles, intravenous equipment, and drug ampoules/vials. In addition, the infectious waste contains pathogenic microorganisms such as cultures and stocks of infectious agents. Planning of waste management system classified as hazardous waste in health facilities. In this planning, initial data is needed in the form of the waste's generation, composition, and characteristics (Wahab & Adesanya, 2011). During the COVID-19 pandemic, issued a discretionary policy to assist health facilities in

managing their waste (Cordova et al., 2021; Sari, Inoue, et al., 2022; Sholikhah et al., 2021). Health facilities can treat their medical waste using an incinerator (minimum combustion temperature of 800°C) or an autoclave equipped with a shredder through this policy. However, the difficulty of the licensing process causes the processing of medical waste to have collaborated with third parties. This study aims to analyze the proper medical waste processing in Jakarta hospitals during the pandemic. The results of this study are expected to be used as a reference in planning the management system and the selection of hazardous waste processing technology in health facilities.

RESEARCH METHODS

This type of research is a descriptive observational study conducted cross-sectional through observations on hazardous solid waste management at Hospital X City of Jakarta. The variables observed in this study include medical waste treatment at the study site.

Data collection uses secondary data collection methods from environmental sanitation installations. The data obtained were then analyzed descriptively and compared with the Minister of Environment and Forestry Regulation Number P.56 of 2015 concerning Procedures and Technical Requirements for the Management of Hazardous and Toxic Waste from Health Service Facilities.

Analytical Hierarchy Process (AHP) is a decision support model developed by Thomas L. Saaty (Saaty, 2003). This decision support model will describe a complex multi-factor or multi-criteria problem into a hierarchy. According to Saaty (2008), hierarchy represents a complex problem in a structure

multi-level where the first level is the goal, followed by the level of factors, criteria, sub-criteria, and so on down to the last level of alternatives. With a hierarchy, a complex problem can be broken down into groups which are then arranged into a hierarchical form so that the problem will appear more structured and systematic. This model is often used as a problem-solving method compared to other plans for the following reasons:

- a) As a consequence of the selected criteria, a hierarchical structure to the deepest sub-criteria.
- b) Considering the validity up to the tolerance limit for the inconsistency of various criteria and alternatives chosen by the decision-maker.
- c) Taking into account the durability of the decision-making sensitivity analysis output

RESULT AND DISCUSSION

Medical waste is processed through an incineration process using an incinerator at Hospital X with a minimum temperature for the primary burner of 800 °C and the secondary burner of 1000°C. The method of extermination with an incinerator is carried out because medical waste is included in the category of hazardous waste, which is infectious and has the potential to transmit disease. The general method was the primary function of incineration technology as a destroyer of infectious medical waste (Vasistha et al., 2018). Other technologies cannot replace in Hospital Dr. Soetomo does incineration every day because the amount of waste generated is quite large (Purwanti, 2015). Haji General Hospital Surabaya, medical waste was destroyed only once every 2-3 days, depending on the amount produced (Keman & Triana, 2006). Paramita also states that medical waste must be processed as soon as possible after it is generated. Storage is the absolute priority if the waste cannot be directly processed (Paramita, 2007).

Hospital X has a medical waste treatment unit only in the form of an autoclave but is used only for highly infectious waste to be sterilized. After that, it is combined with other medical waste to be transported to be processed by a third party. During the Covid-19 era, waste generation increased significantly, causing obstacles faced by third parties. The storage of medical waste in the infectious category for a maximum of 2 days or 48 hours cannot be fulfilled so that it exceeds the stipulated time limit. Therefore, another alternative is needed to manage medical waste at Hospital X.

A thermal process is one of the technologies used to treat medical waste utilizing controlled combustion, transforming waste into ash residue and exhaust gases, and destroying contaminated substances at high temperatures (Suryawan et al., 2022; Zahra et al., 2022). Incinerators can process

waste at a temperature of 800-1100 °C and treat almost all types of medical waste. In addition, incinerators can reduce the volume of waste material. It has been claimed to be the most effective way to destroy infectious and toxic components and significantly reduce the volume and weight of waste (Wahab & Adesanya, 2011).

The autoclave is a medical waste treatment that combines moisture, heat, and pressure to sterilize an object, killing endospores, namely resistant cells produced by bacteria, viruses, and fungi. These cells are resistant to heat, drought, and antibiotics. If the object to be sterilized is thick or large enough, it is necessary to extend the sterilization time. Extended time is also required when large volumes of liquid are autoclaved, as large volumes take longer to reach the sterilization temperature. Autoclave waste treatment offers a less expensive option than incinerators with lower environmental impact and reduced importance of waste residue where landfilling is required. (Goodbody et al., 2013). In processing the waste first, it goes through an enumeration process which can reduce the physical hazards of sharp object waste and reduce the volume of waste. Alternative technology or autoclave can manage the type of infectious waste that landfills cannot.

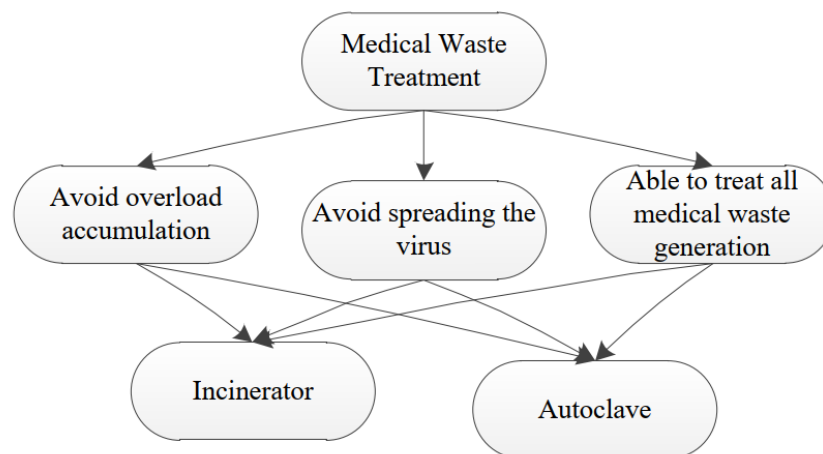


Figure 1. Hierarchy of Selection of Medical Solid Waste Treatment Alternatives

Based on Figure 1, the hierarchy of choosing alternative values to avoid waste accumulation has an index category of 3 because the value is stronger than the risk of transportation delays. The risk of disease transmission follows in Table 1.

After realizing the many obstacles posed by third-party waste management policies on hazardous waste management and the need to reconsider policies in managing waste, waste management should be carried out independently using incinerators or other waste treatment tools. Not all medical waste can be processed using incinerators, such as sharp medical waste, and can use enumeration such as autoclaving, sterilization, and the landfill (Yoon et al., 2022). Infectious waste can be treated using sterilization and incinerators such as culture, serum, vaccines, biological waste, blood, and organs (Huang & Lin, 2008). Infectious, sharp objects and pathological waste can be managed using thermal methods such as incineration (Selvan Christyraj et al., 2021).

Tabel 1. Selection of Alternative AHP Medical Solid Waste Treatment

Criteria	Autoclave	Incinerator	Eigen	Total
Autoclave	1	0.2	0.17	0.33
Incinerator	5	1	0.83	0.83
Total	6	1.2	1	1
λ Max	2			

CI	0
CR	0

The design uses a maximum daily infectious waste generation of 170.6 kg, converted to m³ units, and the combustion chamber volume is 1.5 m³ (Table 2). Based on the design criteria, it is known that for a class B hospital with a waste generation rate of 150 to 200 kg/day, two combustion chamber units are required with a minimum temperature of 800°C and 1200°C, respectively. Therefore, the eco-tech integrated incinerator with a capacity of 2 m³/hour was chosen, with a waiting capacity of 200 kg, two furnaces with a temperature of 1000 – 1200°C and a water scrubber a smoke filter. The fuel used is LPG gas. In addition, incinerators have also been standardized with register number: 038/TRL/Reg-1/KLHK so that the specifications for the use of the equipment conform with Indonesian national regulations and standards. In addition, because currently, the hospital has an autoclave to sterilize highly infectious waste, it can also be used to sterilize sharp medical waste. Another additional unit is needed in a shredder or a chopping machine for sharp medical waste as described in the circular letter number SE.2/MENLHK/PSLhazardouse/PLB.3/3/2020.

Tabel 2. Characteristics of Medical Waste Generation in Hospital X

Parameters	Information	Unit	Source
Hospital	Hospital, East Jakarta, Indonesia		
Medical Waste	0.9	kg/bed.day	(Atthar et al., 2022)
Generation	170.6	kg/day	
	1.5	m ³ /day	
Treatment and Waste Generation	The average daily amount of waste generated is 192.3 kg/day, with 215 beds processed by third parties		

The medical waste incineration process can generate other waste in ash from combustion residues. A strategy is needed to deal with this waste generation so that the final handling does not end in hoarding but can become a functional product. The main constituents of fly ash are Zn and Pb, which are heavy metals due to the metal evaporation process during the combustion process and the metal adsorption process (Suryawan et al., 2019). The solid residue produced from the waste incineration process is about 25-30% of the incineration input. Fly ash is categorized as hazardous waste from general specific sources. Therefore, in handling, it is necessary to carry out management concepts following a hierarchy such as reducing, reusing waste, and last resort in the form of stockpiling. Solidification is a technique for processing incinerator ash residue. Solidification can go through several stages, as shown in Figure 2.

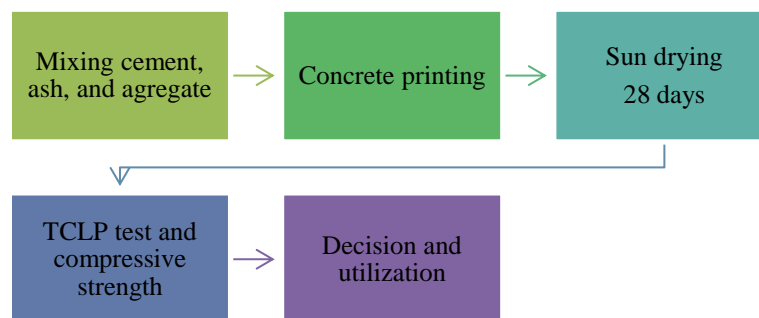


Figure 2. Ash to Concrete Solidification Flowchart

In packaging and storage, waste is separated based on its characteristics, such as sharp medical waste, cytotoxic, infectious, pharmaceutical and chemical waste. For sharp medical waste, it is processed first with an autoclave and a chopper and then sent to the storage room along with cytotoxic and infectious medical waste, while medical pharmaceutical waste and chemicals are returned to the supplier. From the storage room, sharp medical waste is sent to other parties for

further processing. For cytotoxic and infectious medical waste, it is treated using an incinerator and then the remaining ashes are solidified.

Medical waste management system as regulated in Bapedal No. 1 of 1995 consists of stages of reduction and minimization, packaging and container, waste storage, final processing. This has been in accordance with the design of the medical waste management system for health centers in the East Surabaya area, evaluation, and optimization of management were carried out starting from reduction and minimization packaging, packaging and storage, waste storage, final processing (Eldyawan et al., 2016).

Infectious and cytotoxic waste management processes can be managed using incinerators and are able to reduce waste up to 83.63% based on research at Dr Soetopo Hospital with a combustion temperature of 800° - 1000° C (Purwanti, 2015). Based on the design of a simple incinerator to manage medical waste, the incinerator is able to reach a temperature of 998°C and can turn medical waste into ash except sharp waste (Sukamta et al., 2017). Sharps waste treatment using the autoclave method with a shredder is able to sterilize and destroy sharp medical waste so that it can infect viruses and reduce its volume, but the remaining waste must be sent to the B3 waste processor (Tri Nurwahyuni et al., 2020). Utilization of solidification of medical waste incinerator ash at Arifin Achmad Hospital with a percentage of 30% addition of ash and a drying time of 28 days reached the maximum compressive strength of bricks (Gumadita, 2017).

CONCLUSION

An assessment of alternatives indicates that hospitals should optimize the use of autoclaves to generate infectious medical waste and sterilize sharps medical waste. Meanwhile, medical waste treatment using incinerators can generate other waste in the form of ash from combustion residues. Ash from the combustion process can contain heavy metals such as Cr, Zn, and Pb. Therefore, a strategy is needed to deal with this waste generation so that the final handling does not end in hoarding but can become a useful product.

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