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Environmental Impact And Cost Analysis Of Solid Medical Waste Treatment In Hospitals

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Abstract

The purpose of the study was to find the environmental impact and cost analysis of solid medical waste treatment in hospitals. This type of research is a qualitative case study research design. The study was conducted at 3 hospitals in Deli Serdang Regency. Determination of research location based on purposive sampling. The research informants were 9 people. Data collection was done by interview and observation. Data validity is done by triangulation of sources. Data analysis using SimaPro 8.3 software. Reduction of medical waste at the Deli Serdang Regency hospital is carried out through improving environmental management. The waste treatment process that has a high environmental impact is the incinerator and the category of very small impact on the environment is the processing of waste with an autoclave. The biggest cost is treating the waste by autoclave, and chemical disinfection is very small category.

Keywords: environmental impact, cost analysis, solid medical waste, Life cycle analysis, life cycle cost

Introduction

The amount of solid medical waste sourced from hospitals is increasing. The COVID-19 pandemic is one of the triggers for the increasing amount of medical waste from health services. Previous research stated that in March 2020 - February 2021, solid medical waste increased by 6.6 tons, which is estimated to increase by 30-50% [1]. This burden is even more severe if hospitals or health facilities do not treat the waste they produce. Previous data stated that health facilities in North Sumatra Province for solid medical waste processing use waste processing services because they do not have waste processing equipment [2]. Likewise, the Sentra Medica hospital cooperates with third parties for waste treatment[3].

Currently, the hospital in the research location treats waste using a waste treatment service, due to the limitations of waste processing equipment and facilities that are not yet available. However, this imposes a large cost burden for the hospital. For this reason, this study provides input to health service institutions, hospitals and public health centers, for alternative waste treatment based on environmental impact and cost analysis so that it is useful as an option in processing solid medical waste.The amount of waste is significantly related to the number of patients[4].

This research is based on previous research, waste treatment with LCA studies can know the environmental impact and its impact on human health[5]. The life cycle analysis of waste treatment carried out by previous researchers found 4 indicators of greenhouse gas emissions, use of renewable energy, land use and water use [6]. The difference with this research is that it combines LCA and LCC studies so that the results are not only known for environmental impacts but also for consideration of the costs of treating waste. LCA assessment and cost analysis are useful for determining the best processing technique[7]. Unfortunately, Soares' research did not use an incinerator but only 2 types of processing, namely autoclave and disinfection.

Based on the above phenomenon, the formulation of the research problem is what type of solid medical waste treatment has a major impact on the environment? What types of solid medical waste treatment require higher processing costs based on life cycle cost analysis?. This study aims to find the environmental impact and cost analysis of solid medical waste treatment based on Life Cycle Cost and Life Cycle Analysis.

Method

Research type and design

This type of research is qualitative, using a case study design. The case study design, namely observing one problem, carried out a detailed investigation so that the results of the study found the characteristics, nature and phenomena of that one problem [8]. In accordance with the research objective, observing solid medical waste treatment in three hospitals in order to obtain waste treatment that has high to low environmental impact in terms of 3 types of treatment at 3 hospitals in Deli Serdang Regency.

Research informants

The research was conducted in 3 X, Y, Z hospitals in Deli Serdang Regency for 6 months starting from February to July 2021. The research informants were 9 people consisting of key informants, namely 3 waste managers. Supporting informants consist of: 3 cleaning service officers, 3 nurses in the inpatient room.

Data collection and data analysis techniques

Data were collected by interview and observation. The data collection instruments were interview guides, observation guidelines, writing instruments, recording devices. Data validity is done by triangulation of data sources. Observations were made at three hospitals that treat waste with different types of treatment, namely chemical disinfection, autoclave, and incinerator using Life Cycle Cost (LCC) and Life Cycle Analysis (LCA) studies. Data were analyzed using SimaPro 8.3 software.

Results

Research at the Class B General Hospital, Deli Serdang Regency, determined that these three hospitals treat waste by autoclave, incinerator and chemical disinfection. Research informants are shown in the following table:

Table 1 Characteristics of research informants

Informants	Hospital	Age (year)	Sex	Education	Length of work (year)	Duty
1	X	29	Female	Bachelor of Environmental Health	10	Waste treatment
2	X	28	Female	Senior high school	4	Cleaning service
3	X	40	Female	D3 Nursing	13	Nursing
4	Y	37	Female	Bachelor of Environmental Health	15	Waste treatment
5	Y	33	Female	Senior high school	5	Cleaning service
6	Y	33	Female	D3 Nursing	11	Nursing
7	Z	27	Female	Bachelor of Environmental Health	3	Waste treatment
8	Z	21	Female	Senior high school	5	Cleaning service
9	Z	42	Female	D3 Nursing	10	Nursing

Source: primary data, 2021

It is known that all research informants are female, age range 21-42 years. Educational range of informants from high school to bachelor degree. Minimum of 4 years and a maximum of 15 years.

The results of interviews with informants regarding the sorting and reduction and storage of solid medical waste are as follows:

Sorting and Reduction of solid medical waste

X hospital

Nurse; “Never do subtraction. We just found out that waste must be reduced. We only know how to use the tools, drugs and materials provided by the hospital. We only know how to separate waste, according to the trash cans provided by the cleaning service.”

Cleaning service; "We don't do waste reduction, what we know is cleaning the room, picking up trash from the room and delivering the waste to the waste treatment site".

Waste processing officer; “We have never done waste reduction, because our job is only to treat waste, after the waste is sent from the room by the cleaning service officer”.

Y Hospital

Nurse; “We use available medical devices, there are no instructions for reduction, waste from the room is separated by container”

Cleaning service; "As far as we know, we have reduced waste. As far as possible we use materials that do not contain B3, for example, we have replaced thermometers containing mercury with digital ones".

Waste processing officer; "The way we have done is to reduce medical waste by separating recyclable medical waste".

Z hospital

Nurse: “Drugs that are no longer used or that have expired will be handed over to the supplier to be replaced”.

Cleaning service: "We don't sort waste, we take the waste from the room each bag to the final shelter".

Waste treatment officer: “we don't do any reduction, we hand over all solid medical waste to the B3 waste company”.

The analysis of respondents' answers is that the process of reducing medical waste at the Deli Serdang Regency hospital is carried out through improving environmental management. This improvement is carried out, for example by replacing materials or materials that contain B3 into materials or materials that do not contain B3 such as replacing a mercury thermometer with a digital or electronic thermometer.

Solid medical waste storage and treatment

X Hospital

Nurse; "garbage from the room will be taken by the cleaning staff CS to the waste treatment site".

Cleaning service; “waste is taken to a waste treatment site, then the task of the waste processor is to separate and process it”.

Waste processing officer; "we collect waste from cleaning service officers, then we process it into an incinerator"

Y Hospital

Nurse; “Every day the CS staff picks up the garbage. The problem is that sometimes the trash can is full, while the CS officers haven't changed the trash can, so we use aqua boxes or cardboard for medical waste.”

Cleaning service; "Usually 2 times a day will be transported to the waste treatment site".

Waste treatment officer; “Our job is not to separate waste. It was done by the clerk in the room. "

Z hospital

Nurse; "waste is transported by the cleaning service, but sometimes it is full and then removed".

Cleaning service; “We know we only clean the room. The syringe waste is already in the yellow box.”

Waste treatment officer; “solid medical waste treatment through recycling. The types of medical waste that are recycled are used infusion bottles, used hemodialysis fluid packaging, syringe bodies, glass bottles and used plastic medicine bottles".

Based on the results of interviews, medical waste from the room is transported 2 times a day and stored in a temporary storage area (final storege) for B3 waste. The waste that has been sorted in the room will be transported by the cleaning service officer to the waste treatment facility in the hospital.

Furthermore, observations were made at the hospital when processing waste, to determine the environmental impact based on the LCA (Life Cycle Analysis) study. The results of the LCA study are shown in the following table and figure:

Table 2 Environmental impacts by type of solid medical waste treatment in hospitals

Hospital	Processing type	Amount of waste (kg/day)	Necessary materials	Environmental impact
X	Desinfection	18,44	Clorin 5%	Global warming 5,4 $kgCO_2$-eq

Y	Autoclave	86,10	Clorin 5%, electricity 210 kwh	Global warming 20,7 $kgCO_2$-eq
Z	Incenerator	86,41	Solar 46,08 liter	Global warming 24,7 $kgCO_2$-eq

Source: primary data, 2021

The table above shows the results of LCA data analysis, that incinerators cause the highest global warming potential (GWP 100a) namely incinerator 24.7 kgCO2-eq, autoclave 20.7 kgCO2-eq, and chemical disinfection 5.4 kgCO2-eq. Furthermore, the analysis of waste treatment on human toxicity is shown in the image below:

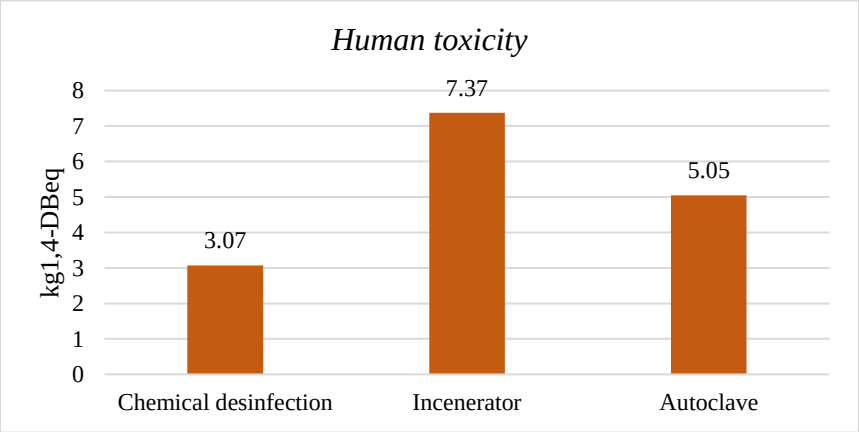

Figure 1. Analysis of the toxicity of waste to humans (human toxicity)

Solid medical waste contains waste made from plastic and contains chlorinated materials, which are the highest sources of dioxin emissions. It is known from the diagram above, the highest human toxicity (HT) was due to the use of an incinerator (7.37 kg1,4-DCB-eq) then autoclave (5.05 kg1,4-DCB-eq) and the lowest was chemical disinfection (3 ,07 kg1,4-DCB-eq).

Based on the weights of the Life Cycle Assessment (LCA) and Life Cycle Cost (LCC), the Eco-efficiency value can be determined by dividing the Life Cycle Cost Score by the Life Cycle Assessment Score as shown in the following table.

Table 3 Value of Eco-efficiency

Processing type	LCA Score	LCC Score	Eco-efficiency
Incenerator	2.06E-10	235010	1.14E+15
Autoclave	1.02E-10	254267	2.50E+15
Chemical desinfection	8.57E-11	209223	2.44E+15

Source: primary data, 2021

Based on the analysis of the impact on the environment and the analysis of costs, it is known that the calculation of the eco-efficiency of waste treatment using an incinerator requires a large cost of Rp. 235,010 and the impact on the environment is in the high category (2.06E-10). Waste treatment with autoclave costs Rp. 254,267, but the impact on the environment is small (1.02E-10). Waste treatment with chemical disinfection costs IDR 209,223 and the impact on the environment is small (8.57E-11).

Discussion

It was found that there are still hospitals that do not have waste treatment facilities. Waste management facilities must have the following requirements: concrete or cement floors, have a good drainage system, available water sources for cleaning, floors are easy to clean and disinfected every day, the location of B3 waste TPS is easy to reach by officers who handle waste, free from flooding, free from flooding. exposed to direct sunlight and rain, the TPS location is not easily accessible by insects, birds or other animals, plastic bags or garbage containers must be close to the B3 waste TPS location and the availability of PPE.

Health services such as hospitals need to prepare waste treatment facilities so that they can not only provide good service to the community but can also participate in preserving the environment and realizing a green hospital [9]. Waste collection in containers is carried out if the volume of waste is or at least 1 x 24 hours [10]. The results of previous studies explained that the transportation of solid medical waste used carts and containers that were closed, colored and easy to clean every day. Waste should not be more than 48 to be treated [11].

The waste treatment officer at the hospital studied had disinfected the waste collection site by spraying it with a 5 percent chlorine solution. Recyclable waste is processed by chopping and cutting using a knife or cutter, then the chopped waste is put into an immersion bath containing 5 percent chlorine solution for 30 minutes. After that, washing is done by putting the waste into a tub containing tap water, then drying it by drying in the sun and storing it in a box or cardboard. This waste is then weighed to be handed over and sold to the utility company. This waste is potentially dangerous because asbestos, lead, damp chemicals, adhesives, fluorescent lamps, chlorine fluoride carbon, are found from hospital waste[12].

Medical waste is treated with an incinerator, but this type of treatment produces emissions. Burning waste using incinerators produces sulfur dioxide gas, nitrogen dioxide, hydrochloric acid, mercury and dioxins which can damage the environment. Therefore, maintaining waste treatment using an incinerator means maintaining environmental pollution [13].

There are hospitals that treat infectious waste with autoclaves, including gauze, rubber pipes, catheters, intravenous sets, diapers, pieces of linen and cotton that are contaminated with the patient's blood or body fluids, masks, gloves, disposable products, intravenous needles, vials, lancets, syringes, pasteur pipettes, hemodialysis filters, glass slides, scalpels, knives, glass, glass bottles, and other infectious waste. This autoclave treatment is carried out to reduce the amount of B3 waste that must be submitted to the B3 waste management company. Waste treatment costs involving B3 waste management companies are very expensive. The average cost of treating waste with a B3 waste management company is IDR 30,000 per kilogram of solid medical waste. The generation of waste in Andahuaylas Province, Apurimac is increasing day by day, therefore the district government needs to strengthen and expand local waste recycling. On the other hand, public awareness needs to be increased [14].

Waste treatment using LCA studies comprehensively assesses greenhouse gas emissions[5]. The same argument is described by Munoz (2020) that life cycle analysis determines the environmental impact of the waste treatment process, so it is useful for making decisions and recycling waste[6]. Good solid medical waste management is determined by the management function of the institution. Previous research stated that nurses and janitors did not know about good waste management. The effectiveness of the waste management system in health services is measured based on the knowledge, attitudes and actions of health workers [15]. Previous research describes that the right strategy focuses on waste sources, this strategic approach involves the concept of human resource management[16].

Conclusion

Analysis of the impact on the environment, the highest category is incinerator, a small category of waste treatment with disinfection, and the category of very small impact on the environment is waste treatment with an autoclave. Cost analysis that requires large costs is autoclave, incinerator, and waste treatment with very small category of chemical disinfection.

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