Hazardous Waste Generation and Composition from Electric Train Activities

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ABSTRACT

Transportation is one of the human needs in a big city like Jakarta. Currently, the implementation of public transportation is being scaled up to reduce vehicle emissions, especially those fueled by oil. One public transportation activity is electric trains that produce hazardous solid waste. This study aims to identify the generation and composition of hazardous waste from electric train transportation activities in Jakarta. This study uses quarterly secondary data from July 2019 to March 2020. The composition of hazardous waste is calculated based on the w/w weight ratio, then looks at the effect of time and phase of each time hazardous waste generation from electric train activities. The composition of the largest hazardous waste is contaminated packaging, scrap-contaminated, and contaminated waste is 28.14%; 23.34%; and 10.72%, respectively. The lowest hazardous waste generated is used lamps at 0.10%. Hazardous waste arises from activities that contaminate to produce hazardous or toxic properties. Based on the phase, solid hazardous waste is 96%, and liquid is 4%. The analysis of the variance test showed no significant difference in terms of time (sig. 0.679) and phase (sig. 0.534). Therefore, the data used show no difference in hazardous waste generated by time or phase.

1. INTRODUCTION

Modern, comfortable, and safe public transportation is everyone's goal. However, many transportations are still uncomfortable and safe, especially in Indonesia [1]. Many transportations are still less convenient to use because many prefer to use private vehicles. The number of private vehicles on the streets makes the roads congested in many places. To reduce congestion that occurs, public transportation is one solution [2]. Convenient and safe public transportation is an option that many people consider. Another option that is also considered as fast is public transportation, which doesn't waste a lot of time

One of the community facilities and infrastructure in public transportation is the electric train [3]. The high-speed train that is being developed uses electric power. The form of management to reduce environmental pollution is the management of Hazardous and Toxic Materials waste.

Hazardous waste from train operations in Indonesia uses used oil, waste oil, residual oil and fuel, contaminated metal, and others [4].

According to the annual report on the operation of electric trains in Vietnam, hazardous waste generated from electric train activities in Vietnam produces residual oil, ink, used lamps, batteries, fuel residue, residual oil, and sludge [5]. Almost the same as the electric train in Columbia, hazardous waste generated from operational activities in the form of paint, asbestos, Printed Circuit Board (PCB), residual oil, residual oil, and other electronic waste [6].

One of the environmental impacts of hazardous waste is soil and water contamination, contaminated with hazardous waste and categorized as an ecological disaster [7]. Ecological disasters will later impact human health, which accumulates into the food chain resulting in poisoning, carcinogenicity, and death [8]. Electric rail trains are electric rail trains that are operated across Jakarta. The use of electric rail is a new thing to operate in Indonesia. Therefore, it is necessary to know environmental management including hazardous waste in this sector. This study aims to identify the generation and composition of hazardous waste from electric train transportation activities in Jakarta

2. METHOD

Secondary data is obtained from the amount of hazardous waste generated, inventory records every day, and based on the hazardous waste manifest used in operations due to the amount of hazardous waste in actual conditions. This data is obtained from the Management's Material Safety Data Sheet (MSDS).

The following secondary data is the time of collecting hazardous waste from each station to the Jakarta electric train depot as supporting data for collecting hazardous waste. This study uses quarterly secondary data from July 2019 to March 2020. The data that has been collected is then processed and analyzed based on their respective functions. The secondary data used is an inventory of hazardous waste data per day. The data processing aims to determine the average hazardous waste from the amount of hazardous waste generated per day according to the characteristics of each hazardous waste generated from electric train operational activities (equation 1):

$$\bar{x} = \sum \frac{x_i}{n}$$
(1)

$\bar{x}$ = average hazardous waste (mass or volume)
n = total sample
x_i = i-th observation value

The average result will determine the hazardous waste generated according to the characteristics. This average can be used to reference hazardous waste stored in temporary shelter. Hazardous waste is stored for three months until a third party transports the hazardous waste.

Hazardous waste composition data in this study were analyzed using the ANOVA test. The ANOVA test compares the population averages to find out the significant differences between two or more data groups. The data group used in this study is the time and phase of hazardous waste to hazardous waste generation at the study site. ANOVA analysis using SPSS.

3. RESULT AND DISCUSSION

Figure 1 shows the amount of hazardous waste generated at an electric train facility in Jakarta. Hazardous waste generated must be appropriately managed and correctly to not harm the environment. Hazardous waste management involves storing, collecting, utilizing, transporting, and handling hazardous waste [9], [10]. This management is expected to minimize the generation of hazardous waste generated by reducing generation from sources by minimizing the use of raw materials that have initially been dangerous to non-hazardous. In addition, using eco-friendly

technology, selecting and implementing reducing environmental scenarios for reducing negative impact more efficient production processes [11].
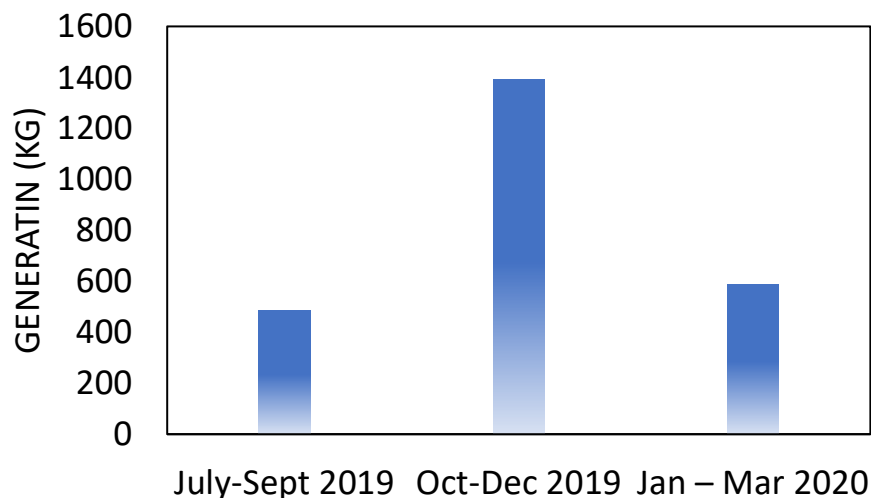

Figure 1. Hazardous Waste Generation Quarterly in Electric Train Facilities

Based on Table 1, the Jakarta electric train hazardous waste composition has various amounts. Hazardous waste that is not necessarily generated per month is grease trap waste, gram lathe residue, used lamps, ferrous metal, used batteries, used rags, contaminated packaging, used batteries, and AC filters. Hazardous waste with the largest percentage is contaminated packaging with 28%, followed by contaminated scrap at 23%. The number of contaminated packaging is greater because it is produced every month. In contrast to contaminated scrap produced only six months earlier, January – March 2020 did not produce contaminated scrap. The smallest percentage produced is used lamps with a value of 0.10%, activities that produce hazardous waste in the form of lamps are only in January – March 2020 with a total of 2.4 kg.

TABLE I. Categories and Composition of Hazardous Waste Electric Train Facilities

Category	Code	July-Sept 2019 Total (kg)	Oct-Dec 2019 Total (kg)	Jan – Mar 2020 Total (kg)	Total (kg)	Type
Grease trap waste	A355-1	0	0	29.8	29.8	Liquid
Used battery	A345-2	0	0	120.4	120.4	Solid
Used oil	B107d	0	0	2.4	2.4	Solid
The remaining grams of lathe	A345-2	0	0	90	90	Solid
Used lamp	A102d	0	51	8	59	Liquid
Metal iron	B110d	5.8	76.8	11.2	93.8	Solid
Second hand	B104d	68	483	142.3	693.3	Solid
Contaminated packaging	B109d	0	61	86	147	Solid
AC filters	B107d	0	37	99	136	Solid
Used battery	B110d	3.2	2.9	0	6.1	Liquid
Scrap contaminated	A108d	407	168	0	575	Solid

Metal drums	B105d	0	188.6	0	188.6	Solid
Medical waste	A377-1	0	58.3	0	58.3	Solid
Contaminated waste	A108d	0	264.2	0	264.2	Solid

Contaminated hazardous waste is hazardous waste that is produced in the largest number and according to PP no. 101 of 2014 is given the code B104d, namely hazardous used packaging with category 2. Hazardous waste contaminated packaging is usually used for garage or workshop activities and used drugs and chemicals, and this hazardous waste is commonly used for industrial factories [12]. Then for hazardous waste, contaminated scrap, namely metal that has been contaminated with dangerously contains toxic properties and according to PP no. 101 of 2014 waste code A108d with category 1. Hazardous waste like contaminated scrap or metal is commonly found in industrial activities [13].

Other hazardous wastes such as used oil, batteries, and rags are hazardous waste originating from waste train facilities [4]. Hazardous waste of used oil used batteries, and used rags need to be managed by hazardous waste by collecting and storing hazardous waste. Grease trap hazardous waste is dangerous liquid waste originating from industrial wastewater treatment by gradually separating oil by gravity [14], [15]. Infectious waste is the result of health activities and infects the body [16]–[18]. Therefore, hazardous waste is categorized as infectious with a total of 58.3 kg with a composition of 2% in October – December 2019 (Figure 2).
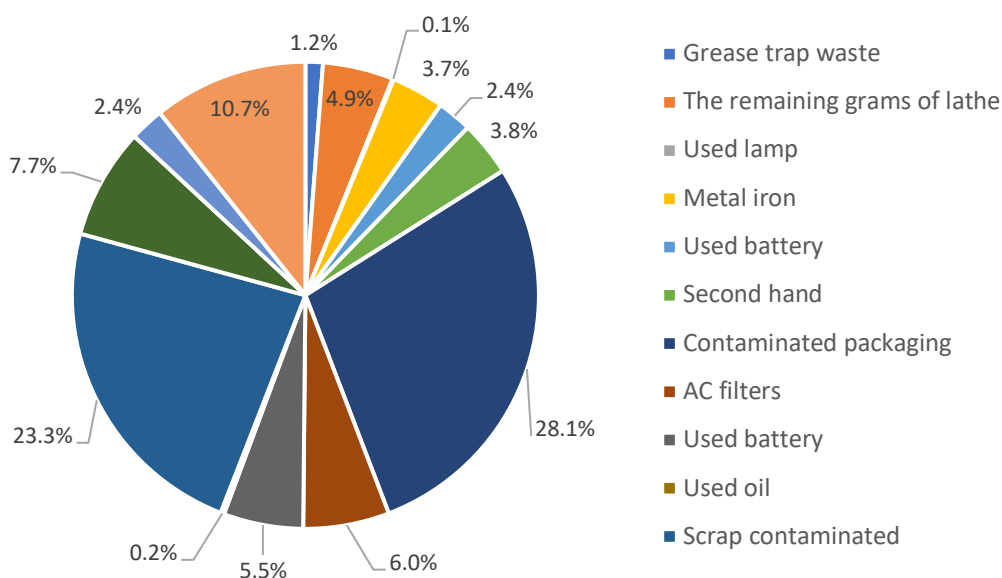

Figure 2. Hazardous Waste Composition in Electric Train Facilities

Figure 3 shows the composition of hazardous waste by phase. Solid waste comes from activities, and business results in solid form. Solid waste is usually found in domestic waste in household activities, trade, offices, livestock, agriculture [19]. The form of liquid waste can be in the form of suspended domestic wastewater or dissolved in water. Meanwhile, hazardous waste is waste originating from business activities and results. It is hazardous or toxic because the nature and amount of the waste will directly or indirectly pollute the environment and/or human health.
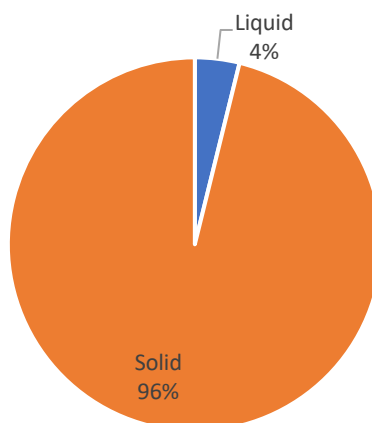
Figure 3. Hazardous Waste Composition Base on Phase in Electric Train Facilities

Table 2 shows the results of the variance test from this study. It can be seen that the phase variable (sig. 0.534) and time (sig. 0.679) of hazardous waste generation are no different from July 2019 to March 2020. Meanwhile, the type of waste generated is also no different.

TABLE II. ANOVA analysis results

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Phase	3.914[a]	23	0.17	0.97	0.534
	Time	14.316[b]	23	0.622	0.819	0.679
Intercept	Phase	79.424	1	79.424	452.718	0
	Time	120.645	1	120.645	158.694	0
Waste Generation	Phase	3.914	23	0.17	0.97	0.534
	Time	14.316	23	0.622	0.819	0.679
Error	Phase	3.158	18	0.175		
	Time	13.684	18	0.76		
Total	Phase	141	42			
	Time	196	42			
Corrected Total	Phase	7.071	41			
	Time	28	41			

[a] R Squared = .553 (Adjusted R Squared = -.017)
[b] R Squared = .511 (Adjusted R Squared = -.113)

4. CONCLUSION

Hazardous waste generated on the Jakarta electric train from July 2019 to March 2020 in the form of grease trap waste, gram lathe, used lamps, metal iron, used batteries, used rags, chemically contaminated packaging, AC filters, and used batteries. Hazardous waste generation with the highest composition is contaminated packaging at 28%, and the smallest is used lamps at 0.10%. Further research is needed on time series management to find out more detailed impacts of electric trains. This management can help prevent the adverse effects of hazardous waste reactions more broadly.

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