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Challenges for Hazardous Waste Management Related to COVID-19 Pandemic at Train Station

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ABSTRACT

The use of public transportation such as train is the practical choice for the capital city people. The active gathering place for people causing waste, in this case, at the station. Various kinds of waste can be generated inside the station, such as wastewater, domestic-like waste, and hazardous waste. In the era of the COVID-19 pandemic, hazardous waste generation is the main focus not to infect humans. The purpose of this research is to examine the management of hazardous waste from the train station. This research uses secondary data from a hazardous waste inventory. The hazardous waste inventory results before the COVID-19 pandemic, hazardous waste generation is only 2.11 kg/day, and 2% are infectious characteristics. Considering that during the COVID-19 pandemic, domestic waste such as disposable masks, used gloves, tissue/cloth containing liquid/nasal and mouth droplets would fall into the category of being treated as infectious waste. Comparison with literature studies shows infectious waste generation at the train station can reach 1.93 - 12.5 L/day. Reservoirs of combustible hazardous solid waste can use used drums, combustible hazardous liquid waste can use HDPE plastic material, and hazardous toxic waste can use fiberglass. Infectious, hazardous waste was put into a container lined with yellow plastic bags with biohazard symbols and given disinfectants such as 0.5% chlorine, Lysol, and carbolic acid. Hazardous waste transportation can use a Stationary Container System (SCS), and officers must use personal protective equipment according to standards. Hazardous waste treatment can use an incinerator or autoclave.

Key words : hazardous waste, solid waste, COVID-19, train station, mask, infectious

1. INTRODUCTION

The train is one of the environment-friendly transportation services. The development of transport will be expected to continue to quite a high increase, so transportation would be a new problem if it does not consider the impact on the environment. It is making the developed country aware of the dangers and impacts of the use of transportations. As in the European Union, trains are an essential part of the goods and passengers' transportation and consider its responsibility for environmental impacts and energy consumption involving the use, maintenance, and improvement of the transportation [1].

The number of vehicles is increasing every year, making the process of vehicle maintenance increasing. In line with the high demand for public transportation such as railways, it can increase the hazardous waste generation. One of the hazardous materials used is oil [2]. After used to lubricate the engine, oil then replaced periodically. This replacement is intended to lessen the damage of engine components that rub against each other in the engine because the oil that has been used contains refined metals from engine components. The number of vehicles is increasing, and cities and regions' rapid development makes the hazardous waste generation increase. Besides the hazardous waste generation from vehicles, medical waste from transportation stations is also a new challenge.

Early June 2020, WHO issued a recommendation for all people to use masks, healthy and sick people [3]. Even though big cities have implemented much work from home [4] [5] [6], there is still a large proportion of workers who have to work from the office. It causes the need for public transportation to remain a priority for most workers. So it is estimated that the generation of infectious waste from the station will still exist.

This suggestion revisions the previous appeal that states that masks are only intended for sick people. This appeal was issued for the coronavirus's current spread and can also be spread by people who have not been symptomatic and airborne. As a result, the use of masks and gloves will increase. The waste contained nasal, and mouth fluid/droplet has the potential to have infectious properties. For this reason, people are required to use cloth masks, which are recommended for only four hours. Therefore, there is a

possibility of an increase in the infectious, hazardous waste generation from disposable materials.

Preventing environmental pollution at the train station and managing non-infectious hazardous waste and potentially infectious hazardous waste must be done on a cradle to grave basis. The management of hazardous waste from the train station related to the COVID-19 pandemic needs to be studied.

2. METHOD

2.1. Data Collection

Primary data were obtained from field observations data with existing hazardous waste management charts, existing hazardous waste collection conditions, and transportation at the train station. Secondary data were obtained from the number of hazardous waste generation inventories recorded every day, and based on the hazardous waste manifest used in operations resulting from hazardous waste in actual conditions.

2.2. Hazardous Waste Management

The components that must be considered are the amount of generation, composition, and hazardous waste characteristics. The amount of hazardous waste generation plays an essential role because the transport and storage capacity of hazardous waste must be considered.

There is a time calculation taken per trip, and the time needed for the SCS system [7]:

$$P_{SCS} = Ct\ uc + (np - 1)\ dbc \quad (1)$$

$$T_{SCS} = Pscs + S + a + bx \quad (2)$$

$$H_{SCS} = \frac{(t_1+t_2)\,Nd\,T_{SCS}}{(1-w)} \quad (3)$$

Where:

P_{SCS} = once taking time (hours/trip)
T_{SCS} = time per trip (jam/trip)
H_{SCS} = time needed for the SCS system
Ct = number of containers emptied once (container / trip)
uc = time for emptying container (hour/trip)
np = number of container locations taken per trip (location/trip)
dbc = time wasted to moving from one location to another (hours/location)
S = time spent on site for waiting loading and unloading (minutes)
t1 = time from the vehicle pool to the first location (hour)
t2 = time from the last location to the vehicle pool (hour)
Nd = number of trips per day (trips/day)
w = off route factor

2.3. Literature Study

A literature study was conducted to determine hazardous waste management and standard operating procedures carried out from the cradle to the grave stage. Some government regulations also become a reference in this research related to collecting, transportation, waste transfer station, waste treatment, and secured landfill.

3. RESULTS AND DISCUSSION

3.1. Hazardous Waste Generation and Composition

The hazardous waste generated is an inventory from July 2019 to March 2020, calculated based on the average load daily. The basis for the hazardous waste generation is essential as a reference for storage requirements. The highest generation is contaminated packaging and contaminated scrap (Table 1). These contaminations could occur because hazardous materials such as oil mixed with packaging and scrap. Contamination can cause changes in the characteristics of non-hazard to hazardous waste.

Table 1: Hazardous waste generation rate at the train station

Hazardous Waste	Hazardous waste generation rate (kg/day)	Characteristic
Grease trap waste	0.03	Liquid
Lathe gram residue	0.10	Solid
Used light	0.01	Solid
Used metal	0.08	Solid
Used storage battery	0.05	Liquid
Used textile	0.08	Solid
Contaminated packaging	0.59	Solid
AC filter	0.13	Solid
Used battery	0.12	Solid
Used oil	0.01	Liquid
Contaminated scrap	0.49	Solid
Metal drum	0.16	Solid
Medical waste	0.05	Solid
Contaminated waste	0.23	Solid
Total	**2.11**	

The medical waste composition is only 2.37% of the total waste generation (Figure 1). This result will be the calculation basis on the prediction of infectious waste generation at the train station. Research in Indonesia shows a 46% increase in medical waste from before the pandemic to May 2020 [8]. With this estimate, infectious waste is generated from medical waste with a total of 0.05 kg/day plus 46%, namely 0.073 kg/day.

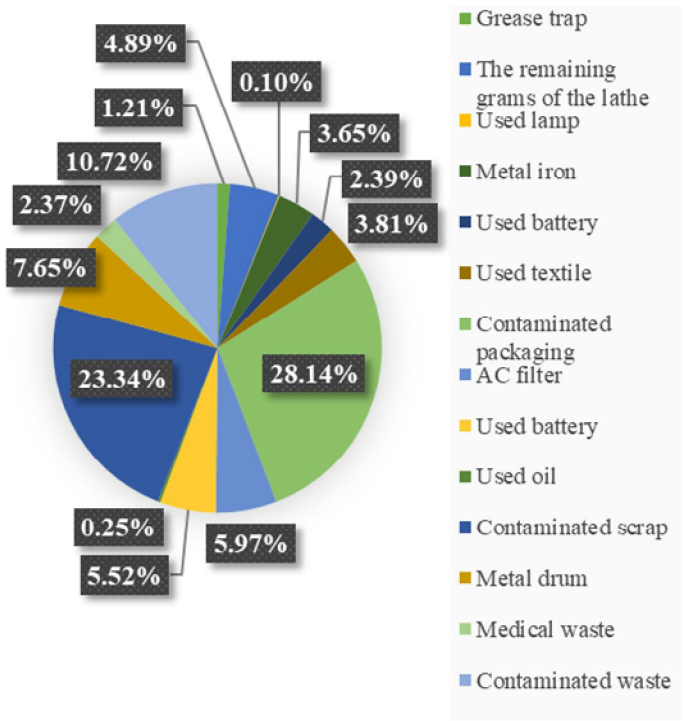

Figure 1: Composition of Hazardous Waste Generated by Train Stations

3.2. Characteristics and Reservoir of Non-infectious Hazardous Waste

Train stations produce hazardous waste with flammable liquid, flammable solid, toxic, and infectious (Figure 2). Wastes with the highest characteristics are flammable solid (82%) or flammable liquid (12%). In comparison, toxic waste is only 4% and followed by infectious waste by 2%.

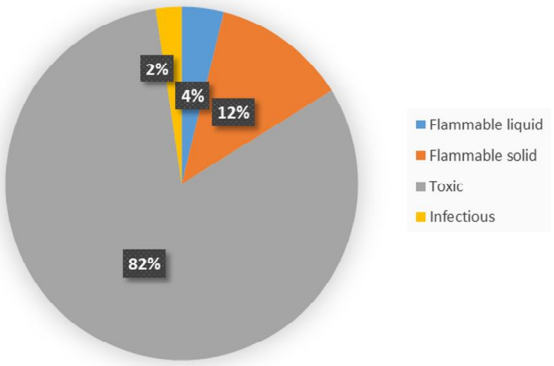

Figure 2: Characteristics components of Hazardous Waste Generated by Train Stations

The combustible hazardous waste reservoir could use used drums with a volume of 78-litres and length x width x height dimensions of 39 cm x 40 cm x 50 cm. The container used for combustible hazardous liquid waste includes 200-litre capacity drums and 660-liter HDPE plastic containers. The 200-litre drum is used for used oil hazardous waste [9]. Used oil storage following Government Regulation No. 101 of 2014 and palletized the drum [10].

Hazardous waste storage for toxic characteristics has hazardous characteristics for living creatures if the toxic substances accumulate in the body. One of the hazardous toxic wastes is metal type, a container that can be used for hazardous metal waste is fiberglass as a deterrent to corrosive materials [11].

3.3. COVID-19 Infectious Hazardous Waste Management Reservoir

Infectious waste is also one of the challenges in the railways' mechanism. The obligation to wear masks and personal protection and the possibility of virus contamination due to human touch increase the amount of infectious waste. For this reason, a specific and more considerable infectious waste storage factor is needed with a capacity of 20 times bigger. If there was no infectious waste container available at the train station, then infectious waste containers were very much needed in the COVID-19 pandemic era.

The number of containers and plastic bags in hospitals is placed in a special room, depending on the size and the solid waste outcome [12]. At the train station, containers are needed at each location, such as gates, ticketing points, and waiting rooms. Separation of domestic solid waste with infectious waste needs to be done by train users and officers. After infectious waste separated from domestic waste, and collected, and then transported, workers must move this medical waste to a temporary storage location.

The container used must contain an infectious symbol, according to Figure 3. Each bag collected may only fill ¾ f the total volume to avoid overloading [13]. One day old trash or already contains 2/3 of the bag must be transported to a temporary collection point. According to the Ministry of Health 2020, domestic solid waste originates from household activities or similar waste, such as food scraps, cardboard boxes, paper, and other organic and inorganic [14]. Mainly, solid waste includes disposable masks, used gloves, tissue/cloth containing nose and mouth liquid/droplets), treated like infectious, hazardous waste [14]. There are at least three domestic solid waste containers available in easily accessible locations at public facilities, such as train stations. Containers for organic solid waste, non-organic solid waste, and particular solid waste (for disposable masks, used gloves, tissue/cloth is containing nose and mouth liquid/droplet). The container is coated with a plastic bag with different colours to make it easy to transport waste and clean the container.

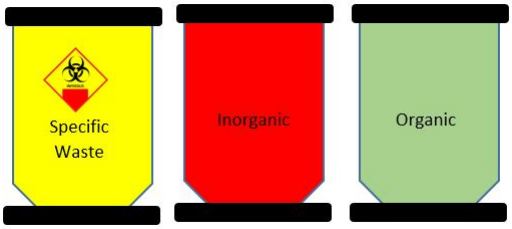

Figure 3: Non-infectious, domestic inorganic, and domestic organic hazardous waste reservoir equipped with symbols and labels

To estimate the number of infections produced at the hospital Yu et al., a generation of 2.5 kg/bed was used.day [15]. Waste generation for train station facilities reaches 1008 – 122 L/day [16]. The infectious waste composition data estimated at 2% of the train stations total waste rate is 2.5 L/station-day in conditions before the COVID-19 pandemic. If the same comparison by Yu et al. is used, the infectious waste generation can reach 12.5 L/day [15]. Hossain et al. stated where the waste container should only be filled by ¾ [13] of the container volume and provide a safety factor of 400% (twice the normal condition before COVID-19). Total infectious waste per day and containerization required showed in Table 2.

However, for the general program, the waste is collected every day for a container without processing in the container. Hospital waste treatment is commonly used in China such as electromagnetic waves with a wavelength of 1 to 1,000 mm and a frequency between hundreds of megahertz and 3,000 MHz or the temperature in the sterilization room is generally set to 134 ° C, and the fluctuation range is less than 3°C [17]. For public facilities refer to the United Nations Environment Program (UNEP), which mentions minimum storage of 3 days before collection [18] so that the volume of containers needed can be unbeatable with the transportation schedule for more than three times a day depending on the specified operational procedures.

Table 2. Estimation of infectious waste from the train station

Station type	Waste Generation	The volume of infectious waste ***	Container volume ****
A*	0.073 kg/day	1.11 L/day	1.93 L/day
B**	2.5 L/day	10 L/day	17.5 L/day

* Station type of this study is a train station in the city (local)
** Station type from [16], is a train station between provinces and local
*** Total volume of infectious waste = generation x density x safety factor.
**** Is the total container requirement with ¾ infectious waste and ¼ being space.

Even though the domestic waste generation has decreased [19], the form of infectious waste contamination to domestic waste needs to be considered so that the waste collection process remains safe. Waste collection from containers is carried out when it is ¾ full. Waste collection officers must be equipped with masks, gloves, boots, and apron. Particular garbage collection officers must be equipped with masks, gloves, boots, apron, goggles, and headgear. The steps carry out the collection: first, open the lid of the trash can and then tie the mop bag by making a knot, and finally put the bag in the container for transport (Figure 4).

Figure 4: Plastic container packaging of infectious waste [20]

After collecting, the officer must clean their entire body or wash their hands with soap and running water. Personal protective equipment includes goggles, boots, and apron, are used to be disinfected as soon as possible in a disinfectant solution. White masks and gloves are disposed of in particular solid waste containers. Organic and inorganic solid waste should be stored in the domestic solid waste temporary station for a maximum of 1 x 24 hours to coordinate with the agency in charge of domestic waste management in the district/city. The domestic solid waste temporary station must be disinfected. Particular solid waste should be stored in a hazardous waste temporary station treated as infectious, hazardous waste. According to UNEP, the challenge of managing COVID19 waste in Indonesia is to seek collaboration with the cement kiln industry, increasing the role of local governments in management, developing health care facilities for waste management in 2020-2024 in 32 locations, with an integrated managed system, utilizing alternative technologies (besides technology incineration), carry out scenarios to improve processing, other treatment/handling for burial and landfilling, another option is to grant special permits for incinerators in locations that have been built but do not meet the criteria [18].

According to the Indonesian Ministry of Health decree, infectious, hazardous waste is inserted into the container/bin covered with a yellow plastic bag with a “biohazard” symbol (Figure 5). The collection of medical waste to the hazardous waste station is carried out using a special transportation tool for infectious waste, and the officer must use personal protective equipment. At the hazardous waste station, hazardous COVID-19 waste packaging is disinfected by spraying disinfectant (according to the prescribed dosage) on bounded plastic waste. The container/bin is disinfected with disinfectants such as chlorine 0.5 %, Lysol, carbolic acid, and others after use.

Figure 5: Infectious waste storage at the waste transfer station.

3.4. Hazardous Waste Transportation

Non-infectious hazardous waste is transported daily to the Hazardous Waste Station. Whereas, particular waste with infectious waste treatment is collected from containers when it is ¾ full or at least once in 24 hours. Transportation of these two waste categories must be separate to avoid contaminating infectious properties into other waste categories.

Based on the Ministry of Health, transportation is carried out using particular waste transportation, and officers must use personal protective equipment. Transport officers who have finished work take off personal protective equipment and immediately shower using antiseptic soap and running water. If processing cannot be carried out immediately, the waste can be stored using freezer/cold-storage, set under 0^{o}C in the waste station. Disinfect the Hazardous Waste Station with 0.5% chlorine disinfectant thoroughly, at least once a day.

The transportation of non-infectious hazardous waste and particularly hazardous waste treated like infectious waste is designed following the Minister of Environment and Forestry Regulation No. P.4 of 2020 [21]. The category of hazardous waste transportation through public roads must be connected to the silacak, such as GPS tracking every transporting hazardous waste following silacak.menlhk.go.id website that has been registered following Appendix 14. Silacak Methods also monitored using a barcode system that has been registered; the mechanism used is the same as electronic.

There must be a document permit from the Ministry of Transportation [5]. The permits can contain information on the producer, amount, type of hazardous waste to transport hazardous waste determined by the agency [11]. The conveyance must be at room temperature and normal pressure because the hazardous waste produced contains combustible hazardous waste. The hazardous waste conveyance must be the symbol of the hazardous waste characteristic that is adjusted to the generation of waste. The inside is coated with a waterproof membrane in the water reservoir.

Transportation methods application for transportation stations such as train stations can use the SCS system. The SCS transportation must be analyzed based on Equations (1), (2), (3). This analysis will produce transportation time per trip. Based on the route from station A to station M (Figure 6).

P_{SCS} = 1 container/trip x 10 minutes/polybag + (13 locations – 1) 6.46 minutes = 87.52 minutes/trip

T_{SCS} = 87.52 minutes/trip + 15 minutes + 0.015 minutes/trip + 29.6 minutes = 133.03 minutes/trip
H_{SCS} = ((((24 minutes + 4 minutes))/(60 minutes/hour) + 1 ((133.03 minutes/trip))/(60 minutes/hour))/((1-0.15)) = 3.06 hours

Thus, the SCS system's time with a route from station A to station M is 3.06 hours. The time of collection and transportation of hazardous waste, ideally, does not interfere with the most populous community activities before 07.00 WIB [22], whereas in the existing conditions of the hazardous waste collection and transportation at the train station can begin at 01.00.

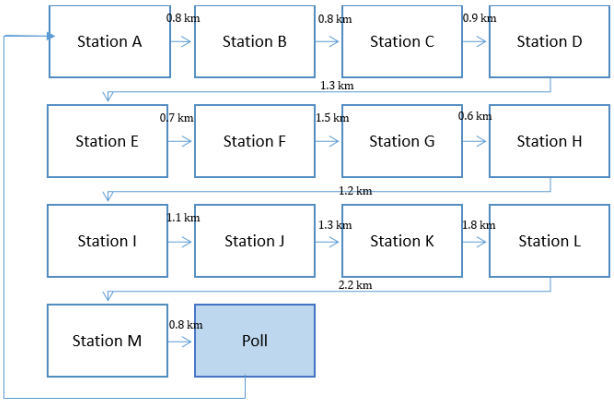

Figure 6: The transportation of hazardous waste with a Stationary Container System (SCS) for the train station

3.5. Particular Waste Management with Infectious Waste-like typed Characteristics

Management of infectious waste from the cradle to the grave and aspects of safety must apply (Figure 7). If adjusted to the Decree of the Indonesian Ministry of Health, particular waste with infectious waste-like characteristics can be treated using an incinerator or autoclave/microwave. In an emergency, the

use of the equipment is excluded from having a permit. The incinerator is an ash/residue packaged in a substantial container to be sent to a licensed hoarder for incineration. The incinerator is one of the technologies that can use infectious waste treatment in Indonesia [23, 24, 25].

Suppose it is not possible to send it to licensed hoarders. In that case, the incinerator is an ash/residue that can be buried according to the construction stipulated by the Minister of Environment and Forestry Regulation number P.56 of 2015 [26]. With the use of autoclave/microwave technology, the residue must be packed in a substantial container. The residue can be buried with the construction stipulated by the Minister of Environment and Forestry Regulation number P.56 of 2015 [26]. For producers who do not have the equipment, they can immediately bury it with disinfection steps in advance with a 0.5% chlorine-based disinfectant. Waste must be damaged so that it is not in its original form to cannot be reused, then buried with construction stipulated in the Minister of Environment and Forestry Regulation number P.56 of 2015 [26].

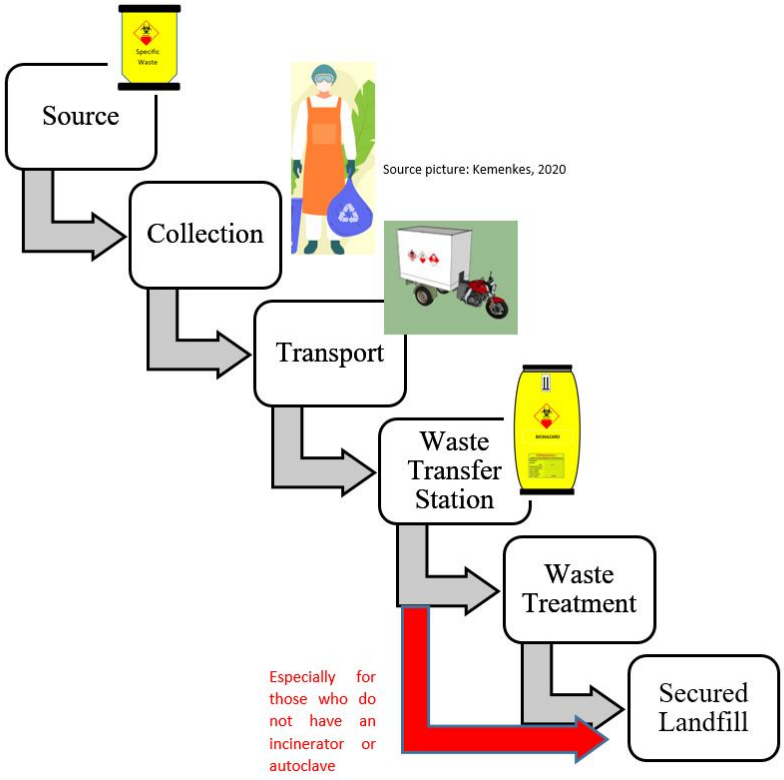

Figure 7: Cradle to grave infectious waste for train station public facilities

4. CONCLUSION

Before the COVID-19 pandemic period, the train station's hazardous waste generation was only 12.5 L/day. Hazardous waste before the COVID-19 pandemic has the characteristics of flammable solid (82%) and liquid (12%), toxic only (4%), and infectious (2%). The estimated infectious waste generation for the train station can reach 1.11 L/day with a 1.93 L/day container integrity for the local station and 10 L/day with a 17.5 L/day container integrity for the interlocal station. The waste must be transported when it is 3/4 full or at least once every 24 hours. The recommended treatment for infectious waste is incinerator and autoclave.

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