

SOLID INFECTIOUS WASTE MANAGEMENT PRACTICES IN A GOVERNMENT HOSPITAL IN CENTRAL KALIMANTAN, INDONESIA

Cindy Dwi Septiana Simangunsong^{1*}, Bambang Yulianto², Ferry Hermawan³

¹Environmental Science Master Program, School of Postgraduate Studies,
Universitas Diponegoro, Indonesia

²Department of Marine Sciences, Faculty of Fisheries and Marine Sciences
Universitas Diponegoro, Indonesia

³Department of Civil Engineering, Faculty of Engineering, Universitas Diponegoro, Indonesia
Email: cindyseptiana@students.undip.ac.id^{1*}

Received : 25 September 2025

Published : 16 November 2025

Revised : 10 October 2025

DOI : <https://doi.org/10.54443/morfai.v5i5.4389>

Accepted : 05 November 2025

Link Publish : <https://radjapublika.com/index.php/MORFAI/article/view/4389>

Abstract

Solid infectious waste management is a crucial aspect of environmental and public health in healthcare facilities. This study aimed to analyze the solid infectious waste management practices at a public hospital in Central Kalimantan based on the Regulation of the Minister of Environment and Forestry (PermenLHK No. P.56/MenLHK-Setjen/2015). This study used a qualitative descriptive approach, including observations, interviews, and document review. Results indicated compliance in segregation, separation, and treatment, while temporary storage was non-compliant, as waste was placed directly in the incinerator area instead of the designated Hazardous Waste Temporary Storage (TPS Limbah B3) which potentially poses environmental risks. Waste generation increased annually, averaging 0.4–0.8 kg/bed/day. It is recommended that the hospital optimize temporary storage, enhance staff capacity through training, and conduct regular waste monitoring to ensure effective and sustainable treatment planning.

Keywords: *Solid Infectious Waste Management, Hospital, Temporary Storage, Environmental Regulation*

INTRODUCTION

Infectious waste refers to all waste generated in healthcare facilities, including hospitals, clinics, blood banks, veterinary hospitals or clinics, and medical laboratories (Makajic-Nikolic et al., 2016). This category includes waste contaminated with blood or other bodily fluids, as well as items that have come into contact with patients (Janmaimool et al., 2024). Improper management of infectious waste poses significant hazards, potentially causing communicable and non-communicable diseases, occupational injuries, and an increased risk of nosocomial infections in hospitals (Janmaimool et al., 2024; Lee & Lee, 2022). Furthermore, environmental contamination of water, soil, and air can occur if waste is not properly handled. Therefore, a comprehensive and systematic approach to infectious waste management is essential to ensure sustainable healthcare services (Alfulayw et al., 2021).

The limited availability of waste treatment facilities, such as autoclaves and incinerators, combined with technical challenges that cause equipment to operate suboptimally, poses a major challenge for many hospitals, particularly in developing countries (Alighardashi et al., 2024). Hazardous waste (B3 waste) generated by healthcare facilities accounts for approximately 58% of the total in developing and low-income countries, which is often disposed of improperly through unsafe methods (Hutajulu et al., 2022). Furthermore, the average generation rate of infectious waste in low-income countries is significantly lower than that in high-income countries. Overall, the average rate of infectious waste generation ranges from 0.3 to 8.4 kg/bed/day (Singh et al., 2022).

The amount of waste generated is disproportionately higher than the amount that is properly managed, suggesting that only a small fraction of waste is adequately treated (BPS, 2024). Consequently, the current hospital waste management system faces significant challenges, particularly in promoting more responsible and environmentally sustainable practices (Ranjbari et al., 2021). In Indonesia, the management of hazardous and toxic waste (B3 waste) is regulated by the Minister of Environment and Forestry Regulation (PermenLHK) No. P.56/2015 on Procedures and Technical Requirements for Managing B3 Waste from Healthcare Facilities. The regulation stipulates that B3 waste generated by healthcare services must undergo several stages: reduction, segregation,

storage, transportation, treatment, burial, and/or disposal (PermenLHK, 2016). One effective strategy is the implementation of circular economy principles, including waste reduction at the source, proper segregation, and the adoption of environmentally friendly technologies, which can minimize environmental impacts and improve hospital operational efficiency (Lee & Lee, 2022). Additionally, establishing infectious waste management strategies that emphasize treatment, recycling, and safe disposal is essential (Attrah *et al.*, 2022). Training healthcare personnel in proper infectious waste management has been shown to significantly reduce the incidence of nosocomial infections, thereby enhancing occupational safety and public health (Ibáñez-Cruz *et al.*, 2025). A government-owned hospital in Central Kalimantan has been authorized by the Ministry of Environment and Forestry to manage its solid infectious waste. Accordingly, this study aims to describe the hospital's solid infectious waste management practices.

METHODOLOGY

This study used a descriptive qualitative approach with direct observations to examine solid infectious waste management practices at a government hospital in Central Kalimantan. Data were collected through observation of waste management activities, including segregation, separation, temporary storage, and treatment processes. In addition, interviews were conducted with sanitarians and cleaning staff, and SOPs and other relevant documents were reviewed. The research instruments were based on the Ministry of Environment and Forestry Regulation (PermenLHK No. P.56/2015) on the management of hazardous and toxic waste from healthcare facilities. Collected data were analyzed descriptively and comparatively by evaluating observations, interviews, and document reviews against the provisions of PermenLHK No. P.56/2015.

RESULTS AND DISCUSSION

Management of Solid Infectious Waste in a Central Kalimantan Government Hospital

Solid infectious waste management plays a vital role in hospital operations, influencing both environmental safety and public health (Negishi & Kawahara, 2023). Effective management practices are essential to minimize occupational hazards for healthcare workers and prevent environmental contamination, as highlighted in previous studies (Lee & Lee, 2022). Evaluating current practices allows for an understanding of how well healthcare facilities comply with national regulations and identifies potential areas for improvement (Yoon *et al.*, 2022). In this study, a government hospital in Central Kalimantan, classified as a Type B hospital with 233 beds, was assessed. Waste management activities are carried out by sanitarians and cleaning staff, beginning with segregation of domestic and infectious waste at the point of generation, followed by separation of sharp and non-sharp waste, temporary storage, and treatment. The results of this assessment, including the sources and types of solid infectious waste generated by each hospital unit, are summarized in **Table 1**.

Table 1. Sources and Categories of Infectious Waste

No	Name of Waste Generating Unit	Name of Room	Types of Solid Infectious Waste Generated
1	Obstetrics	Bengkirai	Masks, alcohol gauze,
2	Perinatology	Keruing	gloves, tongue spatula,
3	Internal Medicine (Male Ward)	Sindur	apron, infus set, blood set,
4	Internal Medicine (Female Ward)	Akasia	blood lines hemodalisasi,
5	Pediatric Ward	Lanan	Infusion bottles, blood bags,
6	Surgical Ward	Meranti	urine bag, foley kateter,
7	VIP Ward	Ulin	NGT, Oxygen tubes, central
8	BPJS Class 1 Ward	Ramin	venous pressure (CVP)
9	VIP	Gaharu	catheters, Endotracheal tubes
10	VIP	Sungkai	(ETT), ventilator tubing,
11	BPJS Class 1 Ward	Beringin	colostomy bags, condoms,
12	Pulmonary Isolation Ward	Nyatoh	and contaminated tissues
13	Psychiatric Ward	Jeluntung	(exposed to sputum, blood, vomit, or patient body fluids).
14	Hemodialysis Unit	Mahoni	
15	Intensive Care Unit (ICU)	ICU	
16	Emergency Department (IGD)	IGD	

Based on **Table 1**, the sources of solid infectious waste come from the inpatient wards. Examples of solid infectious waste generated in the inpatient wards are shown in **Figure 1**.



Figure 1. Solid Infectious Waste From Inpatient Wards

Based on **Figure 1**, examples of solid infectious waste generated from one of the source units include used infusion bottles, infusion tubes, patient diapers, bandages/gauze, and infusion bottles contaminated with patient blood. Proper segregation at the point of generation, combined with the use of personal protective equipment (PPE), is essential to prevent occupational exposure and the spread of infectious agents within the hospital (WHO, 2014; Khan et al., 2023). Systematic monitoring and documentation of waste types and quantities further support efficient waste management and regulatory compliance.

Segregation

Waste from source units is segregated into domestic and infectious types. Domestic waste is collected in black bags, while infectious waste is collected in yellow bags, as shown in **Figure 2**. Proper segregation at the point of generation is crucial to prevent cross-contamination and to ensure that infectious waste is handled, transported, and treated according to established safety protocols. Additionally, training staff in segregation procedures enhances compliance and reduces occupational health risks associated with improper waste handling.

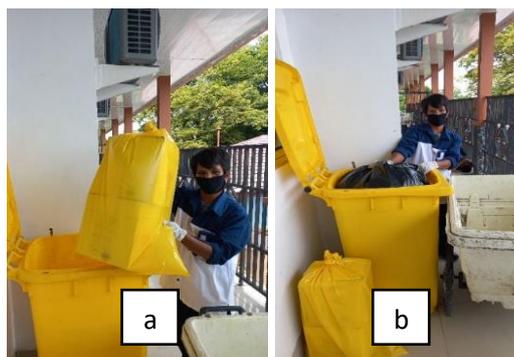


Figure 2. Waste Segregation: (a) Infectious Waste, (b) Domestic Waste

Solid infectious waste management at the hospital follows the Ministry of Environment and Forestry Regulation (PermenLHK No. P.56/2015), which mandates segregation based on waste characteristics. Domestic waste is collected in black bags, while infectious waste is collected in yellow bags, as shown in **Figure 2**. This segregation is essential for preventing cross-contamination, ensuring safe handling and transportation, and complying with regulatory standards. Moreover, it reduces occupational health risks for staff and limits environmental impacts, highlighting the effectiveness of systematic waste management practices in promoting both hospital safety and public health.

Separation

Solid infectious waste is separated into sharp and non-sharp materials. Sharp waste, such as used needles, is placed in safety boxes, while non-sharp waste is collected in yellow bags. The waste is then transported using a dedicated trolley to the temporary storage facility for hazardous waste (TPS for B3 waste), as illustrated in **Figure 3**. This separation is essential to prevent injuries, cross-contamination, and the spread of infectious agents within the hospital. Adherence to proper separation procedures also ensures regulatory compliance and facilitates safe handling,

treatment, and disposal of hazardous waste. Effective implementation relies on continuous training and supervision of hospital staff, highlighting the critical role of systematic waste management in protecting both occupational safety and the environment.



Figure 3. Segregation Process: (a) Safety Box, (b) Non-Sharp Solid Infectious Waste, (c) Transportation Of Solid Infectious Waste To The Temporary Hazardous Waste Storage Facility (TPS For B3 Waste)

As shown in **Figure 3**, the segregation of solid infectious waste complies with the Ministry of Environment and Forestry Regulation (PermenLHK No. P.56/2015), which mandates separation according to waste characteristics. Proper segregation at the point of generation is crucial to prevent cross-contamination between infectious and non-infectious materials, ensuring the safety of hospital staff and patients (WHO, 2014). It also facilitates downstream treatment and disposal processes, supports regulatory compliance, and reduces environmental pollution (Krishnamoorthy et al., 2022). Continuous staff training and adherence to standard operating procedures further enhance the effectiveness of segregation practices, highlighting the importance of systematic waste management in healthcare settings (Ibáñez-Cruz et al., 2025).

Temporary Storage

After being transported from the source units to the temporary hazardous waste storage area (TPS for B3 waste), the solid infectious waste is weighed and recorded in the waste logbook. In practice, the waste is often transported directly to the incinerator area instead of being temporarily stored in the TPS. Staff reported that this approach optimizes time and labor by eliminating the need to re-transport waste from the TPS to the incinerator. This direct transfer also reduces handling, thereby minimizing the risk of occupational exposure and potential contamination. Maintaining proper documentation during transport ensures compliance with regulatory requirements and allows for accurate monitoring of waste quantities. The overall process, combining efficiency, safety, and adherence to procedures, is illustrated in **Figure 4**.



Figure 4. (a) Weighing Process, (b) Transportation To The Incinerator, (c) Placement Of Solid Infectious Waste In The Incinerator Area

Observations indicate that temporary storage of solid infectious waste does not fully comply with the Ministry of Environment and Forestry Regulation (PermenLHK No. P.56/2015), which requires storage in the designated hazardous waste facility (TPS for B3 waste). Waste stored outside the designated TPS may lead to exposure or leakage, contaminating the environment and increasing the risk of infection (Janik-Karpinska et al., 2023). Such non-compliance not only poses health risks to hospital staff and patients but also undermines regulatory adherence and environmental protection efforts. Ensuring proper temporary storage, combined with staff training and regular monitoring, is essential to maintain occupational safety, prevent environmental contamination, and facilitate effective downstream treatment and disposal of infectious waste.

Waste Treatment

Solid infectious waste is treated using an incinerator. The incineration is performed by cleaning personnel wearing full personal protective equipment (PPE), which helps prevent exposure to contaminants and reinforces compliance with safe infectious waste management practices (Khan et al., 2023). Ash generated from the incineration process is stored in dedicated drums and subsequently managed by a licensed third-party hazardous waste company. This process is illustrated in **Figure 5**.



Figure 5. (a) Incineration Process, (b) Storage Of Incineration Ash, (c) Handover Of Incineration Ash To A Licensed Third-Party Waste Management Company

Observations indicate that the treatment of solid infectious waste complies with the Ministry of Environment and Forestry Regulation (PermenLHK No. P.56/2015), which allows treatment via incineration or management by a licensed third-party hazardous waste operator. Proper adherence to these treatment methods ensures that infectious agents are effectively neutralized, reducing the risk of occupational exposure for hospital staff and minimizing environmental contamination. The use of incineration, combined with appropriate personal protective equipment (PPE) and operational protocols, reinforces safe waste handling practices. When incineration is not feasible, transferring waste to a licensed third-party operator guarantees compliance with regulatory standards and supports sustainable management of hazardous materials. Collectively, these practices demonstrate a systematic approach to infectious waste treatment that prioritizes safety, regulatory compliance, and environmental protection.

Solid Infectious Waste Generation

Based on the hospital profile, the facility has a total capacity of 233 beds. The number of beds serves as the basis for calculating the average generation rate of infectious waste, expressed in kilograms per bed per day (WHO, 2010). Ideally, waste generation reporting should be presented in kilograms per bed per day to allow for more accurate comparisons with previous studies (Lim et al., 2024). Standardized measurements also facilitate benchmarking across facilities of different sizes, helping policymakers and hospital administrators to identify trends, allocate resources effectively, and implement targeted interventions for waste reduction. By presenting data per bed, the study ensures that findings are meaningful for both operational planning and public health assessments, supporting evidence based strategies to minimize environmental and occupational risks associated with infectious waste.

Generation of Solid Infectious Waste from 2022 to 2025

To examine trends in hospital solid infectious waste generation, data were systematically collected from 2022 to 2025. The distribution and characteristics of the generated waste are illustrated in **Figure 6**.

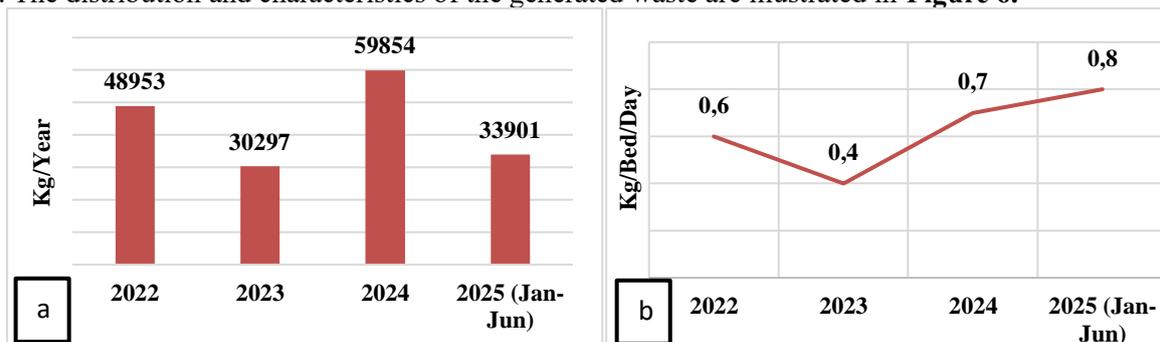


Figure 6. (a) Total Solid Infectious Waste Generation Per Year (Kg/Year); (b) Solid Infectious Waste Generation Per Hospital Bed Per Day (Kg/Bed/Day)

Based on **Figure 6**, solid infectious waste generation fluctuated from 2022 to mid-2025, peaking at 59,854 kg in 2024 and reaching a minimum of 30,297 kg in 2023. On a per-bed-per-day basis, the highest value of 0.8 kg/bed/day was observed in early 2025, and the lowest of 0.4 kg/bed/day occurred in 2023. These trends reflect variations in hospital activity, patient load, and medical procedures over time. Previous studies reported that infectious waste generation was relatively high during the COVID-19 pandemic (Abu-Qdais et al., 2020), with average values ranging from 0.16 to 2.5 kg/bed/day (Lim et al., 2024). Research in hospitals in Bandung and Cimahi indicated an average generation rate of 0.08 to 2.18 kg/patient/day. The primary factors influencing hospital infectious waste generation were the number of patients and medical staff (Bunga & Damanhuri, 2021). Understanding these trends is critical for hospital administrators to optimize waste management strategies, allocate resources efficiently, and implement targeted interventions that minimize occupational hazards and environmental impacts.

CONCLUSION

Management of solid infectious waste at a public hospital in Central Kalimantan generally complies with PermenLHK No. P.56/2015 during sorting, segregation, and treatment. However, at the temporary storage stage, waste is placed directly in the incinerator area rather than in the designated TPS Limbah B3, primarily to save time and labor, indicating partial non-compliance. Waste generation has shown an increasing trend, ranging from 0.4 to 0.8 kg/bed/day. It is recommended that the hospital optimize temporary storage by utilizing TPS Limbah B3 in accordance with regulations, evaluate workflow, and enhance staff capacity through hazardous waste management training. Regular monitoring and recording of waste generation are essential to support accurate planning of treatment capacity and ensure compliance with safety and environmental standards.

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SOLID INFECTIOUS WASTE MANAGEMENT PRACTICES IN A GOVERNMENT HOSPITAL IN CENTRAL KALIMANTAN, INDONESIA

Cindy Dwi Septiana Simangunsong et al

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