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Review
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A Review of Solid Medical Waste Management in Indonesian Hospitals

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ABSTRACT

Background: Hospitals generate hazardous medical waste that threatens both environmental sanitation and human health. Common challenges include a lack of awareness, insufficient training, inadequate disposal infrastructure, and limited resources. Proper management is essential to minimize ecological impacts and prevent hospital-acquired infections (HAIs) at every stage—collection, segregation, transport, and storage. This study systematically evaluates global hospital waste management practices.
Subjects and Method: This study is a systematic review literature review conducted on selected databases (PubMed, Science Direct, Google Schoolar) with a publication year between 2020 and 2025. Literature uses Indonesian and English. The literature included was literature with qualitative and quantitative method. The quality assessment of the literature was carried out using the JBI Critical Appraisal.
Results: The research results from nine (9) articles related to solid medical waste management in Indonesia show that the process of sorting, transportation, temporary storage and final disposal in the management of medical waste from several hospitals has met the requirements in accordance with applicable regulations.
Conclusion: While segregation and temporary storage show high compliance, final disposal remains a critical challenge due to incinerator licensing issues and third-party dependency. Addressing this requires practical staff training, routine audits, and a transition to alternative technologies like autoclaving. Strengthening contract governance and cost-benefit analysis between internal investment and outsourcing is essential for sustainable waste management in Indonesia.

Keywords: Solid, Medical Waste, Management, Hospital

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BACKGROUND

In recent decades, economic growth has spurred a heightened focus on public health, leading to a significant expansion in the number of medical facilities. By integrating primary research such as site visits, surveys, and interviews with secondary data, findings indicate that healthcare waste (HCW) gene-

ration rates fluctuate based on a hospital's specialized services (e.g., pediatric or obstetric) and its administrative tier (central, provincial or district) (Dang et al., 2021).

Health service facilities encompass the infrastructure and instruments utilized for the administration of comprehensive health initiatives including promotion, prevention, treatment, and rehabilitation under the management of national or regional authorities, or the public sector. Globally, the medical industry's environmental footprint is substantial, contributing approximately 4.4% of total net greenhouse gas emissions, placing it among the top five emitting sectors. Furthermore, it represents the second-largest source of landfill waste, second only to the food industry (Corvalan et al., 2020). Hospitals are one of many types of health facilities. Medical waste is the waste generated from the medical activities of health services. The category of medical waste is waste arising from healthcare settings, including hospitals, doctor's offices, dental offices, blood banks, as well as animal care institutions and research laboratories. Generally, medical waste is waste from the health sector that is potentially contaminated by blood, body fluids, or other transmissible substances, and is usually known as regulated medical waste.

Waste resulting from health services, especially hospitals, constitutes all waste generated from hospital activities in solid, liquid, and gaseous forms. Hospital waste that is hazardous and toxic must be handled immediately and appropriately in accordance with the Regulation of the Minister of Health Number 7 of 2019.

The generation of medical waste is experiencing rapid expansion, with an observed annual growth rate of approximately 20% (Mazzei and Specchia, 2023). This increase in medical waste generation is driven by key elements such as an aging demographic, enhanced public health awareness, higher medical service spending, the prevalent use of disposable products, and continuous technological development within the healthcare sector. Crucially, the SARS-CoV-2 (COVID-19) pandemic has significantly exacerbated environmental pollution and the public health crisis surrounding waste management (Liang et al., 2021). The volume of medical waste from 2,813 hospitals in Indonesia reaches 242 tons per day. Thus, from this total, the average waste accumulation reaches 87 kilograms per day, meaning the unmanaged waste is still quite substantial (PERSI, 2018).

Inadequate hospital waste disposal has resulted in severe consequences worldwide, exposing healthcare employees, patients, and local communities to grave environmental and health dangers (Chisholm et al., 2021). Waste generated by healthcare facilities acts as a critical vector for infectious disease propagation, potentially harboring dangerous pathogens and attracting various disease-carrying pests. Furthermore, hospital waste contains various toxic chemicals and sharp objects that can cause health complications and injuries (Zuhriyani, 2019).

The management of solid medical waste in Indonesian hospitals is still not well-managed, thus still having the potential to cause environmental contamination around the hospital (Andolo, 2023). Hospital medical waste is highly hazardous due to its infectious nature, especially when it contains pathogens resistant to multiple antibiotics, such as Staphylococcus aureus and Pseudomonas aeruginosa (Cirstea et al., 2025)

High-income countries generate an average of up to 0.5 kg of hazardous waste per hospital bed per day, while low-income countries generate an average of 0.2 kg.

However, healthcare waste is often not segregated into hazardous and non hazardous waste in low-income countries, making the actual amount of hazardous waste much higher (World Health Organization., 2018)

Hospitals, as health facilities, also introduce effects that need to be regulated, including medical waste which carries hazardous substances due to its dual impact: disrupting environmental cleanliness and human health. Improper disposal of sharp waste (such as used syringes) from infected patients potentially endangers healthcare workers, with a possible infection rate of 30% for HBV; 1.8% for HCV and 0.8% for HIV. The public health consequences of the COVID-19 pandemic prominently revealed the precarious state of medical waste (MW) recycling and management infrastructure, particularly within developing nations (Sonone et al., 2021). This exposure presents a risk for the transmission of blood-borne pathogens, including Hepatitis B and C viruses, as well as Human Immunodeficiency Virus (HIV) (Krivokuća, 2021).

Approximately 85% of the total waste generated by the activities of medical facilities is generally non-B3 (non-Hazardous and Toxic Material) waste. The remaining 15% is considered B3 waste classified as infectious, toxic or radioactive, cytotoxic, and corrosive waste. As reported by the World Health Organization (WHO), the most common problems associated with healthcare waste are: ignorance of the health hazards it poses, inadequate training in proper waste management, lack of waste administration and disposal systems, insufficient economic and human resources, and poor attention given to the issue (WHO, 2024).

The handling of harmful and poisonous healthcare garbage within medical facilities is absolutely essential to minimize environmental impacts and prevent nosocomial infections, carried out through best practices to mitigate such effects. Issues in hospital waste management can arise at any stage: collection, segregation, transportation, and storage (Ciawi et al., 2024).

In this context, our research aims to review the environmental experience of hospitals regarding how to manage healthcare waste in various parts of the world. We want to further understand the process of this waste production and highlight the methods used to address the problem. We analyze the efforts of hospitals and governments in managing healthcare waste and explore the solutions suggested by current researchers.

SUBJECTS AND METHOD

1. Study Design

The strategy and guideline utilized in this study involved a structured examination of existing scholarly works, adhering to the standards established by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses, known as PRISMA. The process of finding relevant information involved searching databases across a range of platforms such as Google Scholar, PubMed, and Science Direct. Keywords searched were ("solid medical waste" AND "management" AND "Hospital").

2. Step of Literature Review

a. Search Strategy

A structured search strategy was developed in September - October 2025 using keywords related to solid medical waste, management, and Hospital. The final keywords used in the electronic searches were "Solid Medical Waste" AND "Management" AND "Hospital". Comprehensive data collection was performed across ScienceDirect, PubMed, and Google Scholar. While the main search was conducted in November 2025, an additional screening was carried out in December 2025 to ensure no relevant studies were overlooked.

b. Selection of the Styudy

The initial search results were compiled into a centralized database to streamline the screening process. After eliminating duplicate entries, the author performed a preliminary assessment of titles and abstracts to identify potentially eligible studies. These selected articles then underwent a rigorous full-text review to ensure strict adherence to the inclusion criteria. Studies that did not align with the specific objective namely, the management of solid medical waste in hospitals were excluded during this phase.

c. Data Extraction

In the subsequent phase, data were extracted from the nine studies that met the inclusion criteria. The extracted information comprising the authors, publication year, research objectives, data collection instruments, methodologies, and key findings was synthesized and presented descriptively. This study focused on data characterization without performing additional statistical analyses.

3. Inclusion Criteria

The inclusion criteria for this study were defined as follows: (1) research focusing on the scope of hospital solid medical waste management; (2) articles published within the last five years, specifically between 2020 and 2025; (3) availability of the full-text version of the manuscript; and (4) studies written in either Indonesian or English.

4. Exclusion Criteria

This study excluded any publications dated before 2020 and those written in languages other than English or Bahasa.

5. Operational Definition of Variables

Solid medical Waste: This denotes the non-liquid remnants from medical treatments or procedures carried out in medical centers; these remnants have the potential to pollute or harm the natural world and/or put people's well being and existence at risk.

Management: is the ability to direct and achieve desired results by utilizing human efforts and other resources

Hospital: A healthcare facility that organizes holistic personal health services, providing facilities for inpatient treatment, outpatient clinics, and emergency medical services.

A medical center: establishment that arranges complete healthcare solutions for individuals, offering resources for hospital stays, walk-in medical consultations, and urgent healthcare assistance.

Literature Review: A literature review offers an extensive overview that consolidates prior investigations concerning a specific subject. It examines academic publications, written works, and additional materials pertinent to a defined field of inquiry, delivering a thoughtful evaluation of the existing comprehension within that area.

6. Study Instrument

The researcher employed the PRISMA Flowchart to illustrate the article selection process. The PRISMA Flowchart is an evidence based tool to enhance transparency and consistency in reporting systematic reviews and meta-analyses. It consists of a set of minimum reporting items that ensure clarity in documenting the selection process. This tool was deemed appropriate for the current study as it improves the quality of reporting in scholarly publications (PRISMA 2020 flow diagram for new systematic reviews, which includes searches of databases, registers, and other sources). Once the article selection process was completed, the researcher conducted a feasibility assessment of the chosen articles using the Critical Appraisal method developed by the Joanna Briggs Institute (JBI). The JBI Critical Appraisal Tools are globally

recognized instruments designed to evaluate research studies' methodological quality and ensure the evidence's reliability and validity (Porritt et al.,2014)

7. Data Analysis

The final stage involves compiling the review results into a well-structured report. This report includes a summary of findings from the selected articles, an analysis of identified patterns or trends, and recommendations or suggestions based on the gaps observed in the existing literature.

RESULTS

The researcher employed keywords and predetermined standards to examine the obtained data, leading to the identification of 97 possibly relevant studies across three sources: Google Scholar (15 studies), PubMed (77 studies), and ScienceDirect (5 studies). The initial pool was then refined by first removing duplicate entries, which accounted for 22 articles, leaving 75 unique studies. After a review of the titles and summaries, 58 more studies were deemed unsuitable and removed, leaving 17 studies for further assessment. From these, another 8 studies were excluded because they did not completely satisfy the predefined criteria. As a result, the final dataset consisted of 9 studies that were deemed suitable for inclusion in the research. The subsequent flow of the study selection is visually presented in the PRISMA diagram.

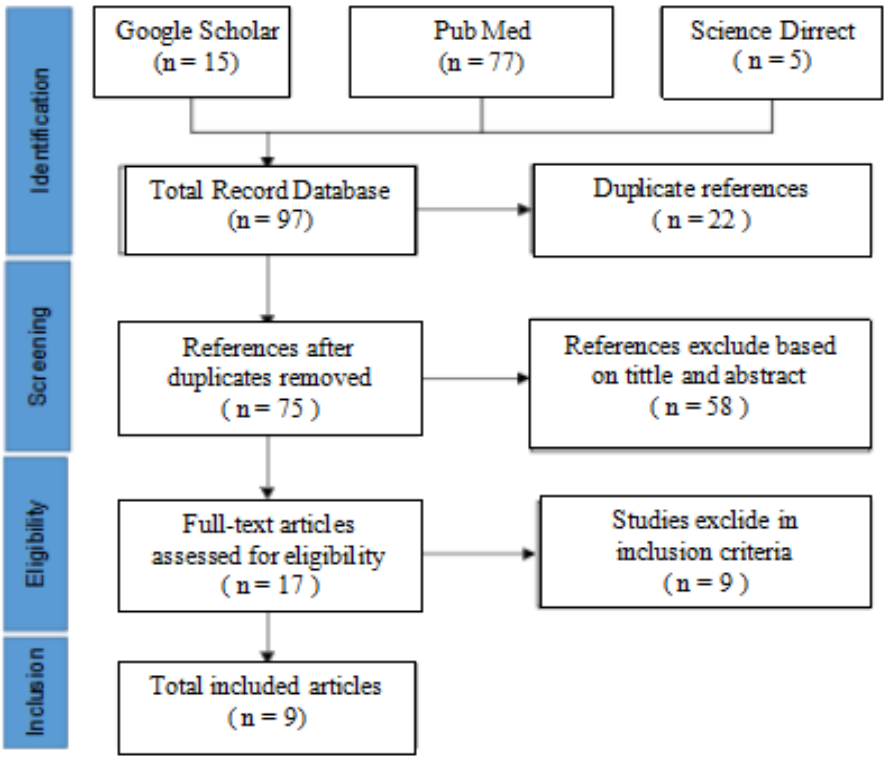

Figure 1. Flow diagram of systematic literature review

Table 1. Summary of article's result of solid medical waste management in Indonesian hospital

Study	Location	Method	Results
Azmiardi et al. (2020)	Ir. Soekarno Regional General Hospital, Sukoharjo, Central Java	Qualitative descriptive research	The processes of sorting and containment of medical waste have been carried out in accordance with requirements, where sorting is performed at the Temporary Storage Area based on waste characteristics. Internal transportation using safe, covered yellow trolleys is also assessed as compliant. The Temporary Storage Area facilities for solid waste have been adequately partitioned and separated. Since the hospital does not possess an incinerator, the Final Disposal is conducted through collaboration with a third party, which is overall judged to meet regulatory compliance.
Arisma (2021)	Hi. Muhammad Yusuf Hospital, Kalibalangan, Kotabumi, North Lampung, Sumatera	Qualitative descriptive research	The processes of sorting and containment of solid medical waste in several rooms are still sub-optimal as medical waste is often mixed with non-medical waste. Although medical waste bags are used, the lack of clear category labeling leads to staff and patients' families failing to dispose of waste into the appropriate containers. Waste transportation is also non-compliant with procedures, using domestic waste trolleys through public pathways. In contrast, the storage stage meets the time requirements (12 hours in the containment area and a maximum of 90 days in the Temporary Storage Area, in line with the volume of 2.1 (kg/day) and physical requirements (permanent, sturdy structure). However, the location of the TPS is deemed not ideal as it is situated close to the inpatient treatment area. The TPS is cleaned twice a week, and waste is transported by the third party when it reaches 100 kg.
Rahdiani et al. (2025)	Ibnu Sina Islamic Hospital, Simpang Empat, West Sumatera	Qualitative descriptive research	The waste segregation process is generally carried out according to the Standard Operating Procedure (SOP), although negligence is still found, where non-infectious waste is mixed into infectious waste. In the transportation route of the new building, the containment of both infectious and non-infectious waste from the operating room and inpatient rooms only utilizes a single, loosely closed trash bin, causing the waste to scatter. Furthermore, transportation in the new building relies only on one dedicated chute, which causes the packaged waste to become mixed when dropped to the ground floor. Meanwhile, temporary storage meets the standards as it is equipped with cold storage for infectious waste and a special compartment for sharp objects. It operates based on SOP, has a responsible officer, and is equipped with appropriate B3 signage, complete PPE, and adequate Occupational Safety and Health (OSH) signs. The final processing is carried out by a legal and licensed third party, with periodic collection (bi-weekly) using vehicles bearing infectious symbol stickers, and is bound by a formal Memorandum of Understanding (MOU) with the hospital.
Pratiwi et al. (2025)	Hajj Hospital, Makassar	Qualitative method	The waste segregation process at Haji Makassar Hospital is judged to be compliant, carried out in every care area using designated containers and color codes, with officers wearing complete PPE. However, the transportation of waste from the rooms by cleaning staff still utilizes public

Study	Location	Method	Results
			corridors and does not use a dedicated route. Meanwhile, waste storage at the Temporary Storage Area is done using special trolleys and has a duration of up to seven days before being transported by a third party. Nevertheless, the excessively open ventilation of the temporary storage area potentially compromises environmental safety as it can be accessed by vectors and animals. Finally, the final processing of infectious waste is not performed independently by the Regional General Hospital because the hospital's incinerator is damaged, meaning all waste is fully handed over to a third party without undergoing burial or landfill processes.
Muhti *et al. (*2021)	Tobelo Hospital, Sulawesi	qualitative method	The segregation of medical waste based on its characteristics across all rooms is declared to be in compliance (meeting the requirements). However, upon further review of the containment aspect (i.e., placement and containers) of medical waste, a lack of uniformity was found: nine rooms met the stipulated containment requirements, but two other rooms were still not compliant. The transportation of medical waste is based on the waste's characteristics. The type of transport used is a trolley; however, the trolley's condition is that it is rarely cleaned and dried. The Temporary Storage Site for solid medical waste is not separated from the TPS for non-medical waste. These two types of waste are collected in one room and placed into drums. Used items like infusion bottles are collected by the waste officers. The Hospital's incinerator facility is not functional, so the destruction of medical waste is outsourced through a cooperation contract with a third party. The disposal of the hospital's domestic/non-medical waste is carried out through cooperation with the Department of Sanitation, which is responsible for transporting the waste to the Final Disposal Site.
Hutajulu *et al.* (2022)	X Hospitals, Indonesia	Quantitative method	The quality of this waste management is heavily influenced by hospital policies, including the availability of regulatory documents and Standard Operating Procedures (SOPs), which are proven to significantly shape human resource behavior. In addition to policies, the completeness of facilities such as appropriate waste containers, personal protective equipment (PPE), and closed transportation means is a crucial factor in determining successful and more effective medical waste management. The processing methods used, such as incinerators, autoclaves, and chemical disinfection, also play a decisive role in optimizing waste management to reduce environmental burdens and contamination risks. Effective management strategies must be carried out systematically, starting from the stages of reduction and sorting, storage, and transportation, through to processing and final landfilling. Improving human resource competence through regular training is a vital priority to enhance the knowledge, attitudes, and actions of medical staff and cleaning officers when handling hazardous waste. Implementing strategies based on strong policies, adequate facilities, and good work behavior not only minimizes negative environmental

Study	Location	Method	Results
			impacts but also provides benefits in terms of cost efficiency and prevents work accidents or cross-infections within the hospital environment.
Palita, Purnawen i and Luqman (2024)	Undata Regional General Hospital, Palu, Central Sulawesi	Qualitative method	Hospital waste management quality is driven by institutional policies and SOPs, which significantly shape staff behavior. This is crucial in Indonesia, where only 42.58% of hospitals meet standards despite generating 290 tons of medical waste daily. Success also depends on proper facilities such as standardized containers and PPE and systematic processing methods like incineration or autoclaving. An integrated strategy ensures regulatory compliance while improving cost efficiency and safety for healthcare workers
Israr et al., (2024)	X Hospital in West Sumatra	Mixed method (qualitative and quantitative studi)	Solid medical waste at Hospital X is dominated by the infectious category (67%), with an average generation of 56.53 kg/day or 0.339 kg per patient. There is a very strong positive correlation (r = 0.851) between the number of patients and the volume of waste produced, indicating that an increase in healthcare activities directly raises the burden of hazardous waste that must be managed. Overall, the waste management compliance level reaches 80% (classified as 'good'), although challenges remain in the sorting, containerization, and staff PPE compliance stages. For optimization, the hospital needs to complete supporting facilities according to standards (such as hazardous waste trolleys) and provide continuous education for staff to prevent the risk of cross-infection and environmental pollution.
Alhamda and Herawati (2023)	X Hospital in West Sumatra	Qualitative studi	Solid medical waste management in West Sumatra hospitals faces significant regulatory gaps, with many facilities fail to meet national standards for segregation and storage. Despite generating nearly 1,900 tons of hazardous waste annually, many hospitals lack essential equipment like spill kits and fail to use standardized color-coded containers correctly. This leads to the dangerous mixing of infectious, radioactive, and general waste, increasing the risk of environmental contamination and public health threats. The effectiveness of the system is further undermined by high operational costs and human resource limitations. Most hospitals rely on expensive third-party services in Java for waste disposal due to a lack of on-site treatment facilities. Furthermore, while initial training is common, the lack of continuous education for cleaning staff who often have lower education levels leads to frequent handling errors and needle-stick injuries. An integrated approach combining better financing for infrastructure and ongoing staff training is essential for a sustainable management system.

DISCUSSION

Medical waste is largely composed- of medical waste, which presents a possible danger due to the presence of disease-cau- sing organisms. Because it a stems from human actions, the creation of this waste will undoubtedly persist into the future knowledge among the public about how hospitals handle their waste has grown around the world, particularly in nations

with developing economies where the money and technology needed to handle medical waste are in short supply.

To avoid the emergence of hospital-based infections, it's crucial to handle waste properly and securely during its various phases, including gathering sorting, keeping, moving, and processing. Because it can spread illnesses such as HIV/AIDS, Hepatitis B, Hepatitis C, and other diseases transmitted through blood, handling medical waste demands substantial consideration. The process of handling solid medical refuse involves four distinct phases: initially decreesing and sorting the waste, then moving it within the facility, followed by holding it briefly, and finally, treating it on-site.

Solid Medical Waste Segregation

Overall, the medical waste segregation process across the nine hospitals shows mixed results. Ir. Soekarno Hospital complies with segregation requirements at the Temporary Storage Site and containment, while Haji Hospital Makassar implements a color-coded segregation system in every care area, with staff wearing complete Personal Protective Equipment (PPE). Conversely, RS Hi Muhammad Yusuf and Islam Ibnu Sina Hospital do not meet the standards. Muhammad Yusuf hospital reports waste mixing and unlabelled packaging, while Islam Ibnu Sina hospital shows delays in waste segregation and inadequate packaging in the transportation chute, utilizing a single, uncovered container. Meanwhile, Tobelo Hopital successfully segregates waste in all rooms but exhibits inconsistency in containment in two of its rooms, requiring improvement. Solid medical waste at Hospital X challenges in the sorting, containerization, and staff PPE compliance stages. Solid medical waste management in West Sumatra hospitals many hospitals lack essential equipment like spill kits and fail to use standardized color-coded containers correctly.

Segregation of solid medical waste by type at the source is a crucial stage in medical waste management. Effective segregation not only enhances occupational safety and minimizes the risk of disease transmission among personnel but also prevents the hazards posed by waste containing hazardous and toxic materials (B3) to public health and the environment if not managed correctly.

Source segregation is identified as a critical initial step in medical waste (MW) management, as it determines the ultimate destination of the material whether for recycling, reuse, or specialized treatment. Waste classification is based on its composition and the appropriate disposal method within the waste flow (Windfeld and Brooks, 2015). Non-hazardous MW is separated and managed alongside municipal waste, given that it poses negligible risk to both human health and the environment. Conversely, hazardous MW mandates specialized treatment procedures (Kantor and Abramovich, 2012).

Effective waste segregation provides significant advantages, primarily by lowering transportation costs and reducing the total volume of the waste stream. By preventing the cross-contamination of medical waste with non-medical materials, it mitigates health risks and environmental pollution while ensuring that only hazardous waste is treated. Furthermore, source separation is a prerequisite for waste valorization; by excluding materials with low energy potential, it optimizes the efficiency of waste to energy recovery processes (Mazzei and Specchia, 2023).

Solid Medical Waste Transportation

Ir. Soekarno hospital has implemented compliant procedures, utilizing a covered yellow trolley for safe transportation. In

contrast, Hi Muhammad Yusuf hospital Kalibalangan violates procedures by using an uncovered domestic waste trolley through public pathways. Although Hajj Makassar hospital correctly executes the waste handover procedure to a third party (including PPE, packaging, and weighing), internal transportation from the rooms to the segregation area still uses general corridors and has not utilized a dedicated route.

Internal transportation is carried out in Health Service Facilities using a covered, wheeled conveyance toward the temporary storage site for hazardous and toxic waste. The intended conveyance can be a trolley or a closed container. Waste transportation must follow a dedicated route and specific time, avoiding contact with food supply or clean linen routes. Transport personnel must use standard-compliant PPE.

Prior to final disposal, medical waste (MW) generated in healthcare facilities must be temporarily transferred to a pre-designated on-site area. This storage location should meet specific structural and operational criteria It must be a closed room or dedicated enclosure, The space must be sufficiently extensive to accommodate the maximum expected volume of waste, It is mandatory that different waste categories be stored independently (segregated). The facility must be appropriately equipped, including suitable provisions for the refrigerated storage of waste in designated cold rooms when necessary (Krivokuća, 2021).

Within the storage area, medical waste (MW) must be contained according to its type, group, and specific hazardous characteristics. The containers used for this purpose are required to possess several key physical attributes: they must be strong, rust-resistant, difficult to open, watertight, and equipped with a functional lid. Furthermore, the implementation of labels and hazardous material symbols on these containers is strongly advised to mitigate occupational risks and ensure safety. Following on-site storage, the MW is subsequently transported to the designated disposal facility. Upon arrival at the disposal site, the waste's weight must be verified to prevent losses or discrepancies during transit, ensuring accountability (Sutrisno and Meilasari, 2020).

Solid Medical Waste Temporary Storage

The evaluation of solid medical waste management at the temporary storage site in various health facilities reveals differences in standard operational implementation. Muhammad Yusuf Kalibalangan and Ir. Soekarno hospitals show compliance with procedures, where Muhammad Yusuf hospital adheres to waste storage time limits (maximum 12 hours in the container and 90 days at the temporary storage site), while Ir. Soekarno hospital performs separation and categorization of waste at the temporary storage site. Ibnu Sina islamic hospital even possesses adequate storage facilities, such as a refrigerator for infectious waste, a special compartment for sharp objects, assigned personnel, and standard safety equipment like PPE, APAR, and appropriate B3 signage. On the other hand, Hajj Makassar hospital faces environmental risk due to the open design of the temporary storage site, which could allow access by vectors such as animals, insects, and birds. The worst situation is found at Tobelo hospital, where the solid medical waste temporary storage site is not separated from the non-medical waste temporary storage site, and the waste is collected together in a single drum in one room, indicating a high potential for cross-contamination risk.

Hazardous and toxic waste must be held in authorized interim facilities that maintain valid permits in compliance with current legal frameworks and regulations. This involves using packaging made of metal or plastic materials that can contain the B3 Waste according to its characteristics, capable of fully containing the B3 Waste within the packaging, having a strong lid to prevent spills during storage, transfer, and/or transportation, and being in a condition that is not leaking, not rusty, and not damaged. The permissible duration for medical waste storage is determined by both ambient temperature and specific waste classifications, including infectious, sharp, pathological, and other medical waste categories.

According to other research, garbage shouldn't be kept in temporary storage spaces for longer than three to four days.The risk of infections and illnesses rises when garbage is stored for more than six months. Cockroaches and mosquitoes may find breeding sites as a result of improper disposal (Ulhaq et al., 2025).

Solid Medical Waste Treatment (Final Processing)

Due to internal operational challenges, the health facilities reviewed primarily utilize cooperation with external service providers for the final treatment of their solid medical waste. Ir. Soekarno, Hajj Makassar, Tobelo, and West Sumatra hospitals all rely on external parties for medical waste destruction because the hospital's internal incinerators are damaged or non-existent. in Undata Regional General Hospital, Palu city, Central Sulawesi Success on proper facilities such as standardized containers and PPE and systematic processing methods like incineration or autoclaving.

This is considered compliant, provided the external party holds a valid permit. RS Islam Ibnu Sina is highly compliant with waste management procedures. They have a formal contract (MoU) and use a legitimate, licensed waste transporter with vehicles bearing infectious waste symbols. Transportation is conducted every two weeks. In contrast, Muhammad Yusuf hospital cleans the temporary storage site twice a week and dispatches solid medical waste to the external party when its weight reaches 100 kg. Generally, there are no reports of storage or burial of infectious waste in these hospitals, as all waste is sent and transported by licensed external parties.

Transportation officers often handle the transfer of medical waste from special B3 temporary storage sites to the waste treatment destination during the transportation phase. Working together with transportation service providers, a number of hospitals manage the entire transportation of their waste, which is then handed over to a medical B3 waste processing company. Each time a load of waste is transferred by the parties, a documented proof of handover or a B3 waste manifest must be included, which is provided at the time of the waste handover (Sutanto and Karianga, 2023).

Globally, the treatment of healthcare waste is dominated by five core technologies: incineration and steam sterilization, alongside increasingly common methods like chemical disinfection, microwaving, and landfill disposal (Windfeld and Brooks, 2015) (Kumar et al., 2004). The most popular and widely utilized technology in the world is incineration. As a result, a significant portion of waste in the nations with the highest waste production gets burned (Hamidinasab and Nabavi-Pelesaraei, 2025). Beyond mere legal compliance, effective medical waste management is fundamentally a social responsibility. Achieving this requires actively

promoting awareness through targeted training programs and health education initiatives. Such efforts are crucial for mitigating risks, which include reducing occupational accidents and minimizing environmental contamination associated with improper medical waste handling (Expoto et al., 2022).

By establishing a priority-based strategy, healthcare facilities can formalize SOPs that integrate the full spectrum of waste management, beginning with source reduction and sorting, followed by secure storage, transit, processing, and eventual burial or landfilling (Singh et al., 2024). In order to lessen the quantity of garbage in landfills, people ought to take part in the creation of SOP management rules by classifying waste (Sidrotul et al., 2022). Additionally, segregation is a crucial step (Arisma, 2021) and planning was identified as the main waste management method .

The effectiveness of managing waste is greatly determined by the guidelines hospitals set, such as having access to official rules and step-by-step guides, which have been shown to greatly affect how staff act. Aside from these guidelines, having complete equipment like suitable bins for waste, safety gear for individuals, and secure ways to move waste is very important for ensuring medical waste is managed successfully and efficiently (Ahmad et al., 2024).

Benefits of standard-compliant management include cost savings, convenience of administration, and the avoidance of hazardous infections in waste management and medical personnel. By appropriately separating toxic and non-toxic waste and using particular treatment for pathological waste management, cross contamination can be avoided (Geetha et al., 2019).

Although hospital solid medical waste management has achieved satisfactory compliance from the segregation to temporary storage stages, critical bottlenecks remain at the final disposal phase. Technical and licensing issues regarding on-site incinerators have forced hospitals to rely on third-party services, leading to increased operational costs and chain of custody risks. To address this, it is essential to strengthen practical training programs such as PPE usage and safe disposal techniques—coupled with routine audits and the development of national policies with clear enforcement mechanisms. Furthermore, hospitals are recommended to conduct technical audits of existing incinerators and transition toward alternative technologies like autoclaving to reduce incineration dependency. As a strategic step, strengthening contract governance, rigorous manifest monitoring, and cost benefit analysis between internal investment and outsourcing are vital to ensure the sustainability of waste management systems in Indonesia

AUTHOR CONTRIBUTION

Anggreini Beta Citra Dewi Is the main researcher who select the topic, explores and collects data. Ervansyah Wahyu Utomo, Siti Rachmawati And Aurina Firda Kusuma Wardani played a role in analyzing data and reviewing re- search documents.

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CONFLICT OF INTEREST

The researchers affirm that this investigation was carried out without any business ties or monetary associations that might be understood as a possible clash of interests.

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