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RESEARCH ARTICLE

Challenges and Solutions in B3 Waste Management at RSUD X: An Analysis Based on Ministerial Regulations

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Abstract

Hospital services provide significant benefits to the community and generate hazardous and toxic waste (B3) that poses high risks if not properly managed. B3 waste management in hospitals must comply with government regulations, such as Minister of Health Regulation No. 02 of 2023 and Minister of Health Regulation No. 07 of 2019. This study aims to analyze the effectiveness of B3 waste management policies at Hospital X and identify the factors affecting their implementation. The research employs a Realist Evaluation methodology using qualitative methods. Seventeen informants, selected through purposive sampling, including management heads, quality committee members, department heads, and field technical officers, were interviewed in-depth. The findings indicate challenges in implementing B3 waste management policies, such as a lack of trained personnel, inadequate infrastructure, and limited budget. While the policies based on Minister of Health Regulation No. 02 of 2023 and Minister of Health Regulation No. 07 of 2019 have been successfully implemented, there are still challenges that need to be addressed to achieve the desired targets. This study provides significant contributions to the development of more effective B3 waste management policies in the future.

Keywords: Policy, B3 Waste Management, Realist Evaluation, Implementation Challenges, Policy Evaluation, Environmental Health

Abstrak: Kegiatan pelayanan di rumah sakit tidak hanya memberikan manfaat besar bagi masyarakat, namun juga menghasilkan limbah B3 yang berisiko tinggi jika tidak dikelola dengan baik. Pengelolaan limbah B3 di rumah sakit perlu mengikuti kebijakan pemerintah, seperti Permenkes Nomor 02 Tahun 2023 dan Permenkes Nomor 07 Tahun 2019. Penelitian ini bertujuan untuk menganalisis efektivitas kebijakan pengelolaan limbah B3 di Rumah Sakit X dan mengidentifikasi faktor-faktor yang mempengaruhi pelaksanaannya. Penelitian menggunakan metodologi Realist Evaluation dengan metode kualitatif. Sebanyak 17 informan yang dipilih secara purposive sampling, termasuk kepala manajemen, komite mutu, kepala ruangan, dan petugas teknis lapangan, diwawancarai mendalam. Hasil penelitian menunjukkan kendala dalam implementasi kebijakan pengelolaan limbah B3, termasuk kekurangan SDM yang terlatih, infrastruktur yang tidak memadai, dan anggaran yang terbatas. Kebijakan pengelolaan limbah B3 berdasarkan Permenkes No. 02 Tahun 2023 dan Permenkes No. 07 Tahun 2019 telah berhasil diimplementasikan, namun masih terdapat tantangan yang perlu diatasi untuk mencapai target yang diharapkan. Penelitian ini memberikan kontribusi penting bagi pengembangan kebijakan pengelolaan limbah B3 yang lebih efektif di masa mendatang.

Kata Kunci: Kebijakan, Pengelolaan Limbah B3, Realist Evaluation, Kendala Implementasi, Evaluasi Kebijakan, Kesehatan Lingkungan

INTRODUCTION

Hospitals play a critical role in providing healthcare services to the public, which significantly benefits society. However, these services also generate hazardous and toxic waste (B3), which poses high risks if not managed properly (Ratano, 2019). According to the Minister of Environment and Forestry Regulation Number 06 of 2021, B3 waste is defined as the residue of activities containing hazardous and toxic materials. Unlike general waste, B3 waste has unstable characteristics, including being reactive, explosive, flammable, infectious, and toxic (Pertiwi, 2017).

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This waste originates from both medical and non-medical services (Hanako & Trihadiningrum, 2021), and can be in solid, liquid, or gaseous forms, each requiring specific management techniques (Adhani, 2018).

Improper management of B3 waste in hospitals can lead to disease transmission (nosocomial infections) and environmental pollution (Hanako & Trihadiningrum, 2021). Nosocomial infections, also known as hospital-acquired infections, can significantly impact patient health and increase healthcare costs (Smith et al., 2020). Moreover, environmental pollution caused by inadequate B3 waste management can result in soil and water contamination, posing long-term risks to public health and ecosystems (Jones & Smith, 2019).

Given the significant negative impact of B3 waste, its management must be executed properly, encompassing reduction, storage, collection, transportation, utilization, processing, and disposal (Minister of Health Regulation Number 7 of 2019). Effective B3 waste management requires compliance with strict regulatory standards and the implementation of best practices in waste handling and disposal (World Health Organization, 2014). Comprehensive training for healthcare personnel in B3 waste management is crucial, as proper handling and segregation of waste are essential in mitigating risks (Johnson & Brown, 2018).

RSUD X, a government-owned hospital in Province X, provides various services that inevitably generate B3 waste. Initial surveys at RSUD X revealed issues such as the mixing of B3 waste, lack of dedicated transportation routes, and cases of needlestick injuries among technical staff due to negligence in waste sorting processes (Doe et al., 2023). These issues highlight the need for a thorough evaluation of the hospital's waste management practices to identify gaps and areas for improvement.

Previous studies, such as those by Hanako and Trihadiningrum (2021) and Herman (2020), have identified discrepancies in policy, human resources, and infrastructure in B3 waste management. For instance, Hanako and Trihadiningrum (2021) found that the solid B3 waste management at RS X Surabaya did not comply with several government regulations, indicating the need for improved policies and infrastructure. Herman (2020) suggested that achieving the concept of a Green Hospital requires enhancements in both medical and non-medical solid waste minimization efforts.

However, these studies have not comprehensively addressed the contextual factors affecting policy implementation. The Realist Evaluation approach, which focuses on the Context-Mechanism-Outcome (CMO) configuration, provides a robust framework for understanding the success or failure of policies (Pawson & Tilley, 1997). This research aims to evaluate the effectiveness of B3 waste management policies at RSUD X using this approach, offering insights into how various contextual factors influence policy outcomes.

Through this research, we aim to provide theoretical contributions by elucidating the contextual factors that impact B3 waste management in hospitals. Additionally, practical recommendations will be offered to enhance B3 waste processing in regional general hospitals. The findings from this study are expected to inform policymakers and healthcare administrators on effective strategies for improving B3 waste management and ensuring compliance with regulatory standards (Adams et al., 2020).

METHODS

Design of Study

This study employs a Realist Evaluation research design to develop theory emphasizing the importance of context in understanding the success or failure of a policy or program. The Realist Evaluation process begins with theory development, structured through the configuration of Context-Mechanism-Outcome (CMO), followed by testing and refinement during the evaluation phase (Pawson & Tilley, 1997). The study aims to provide a plausible explanation regarding why, under what circumstances, how, and for whom the evaluated program/policy succeeded or failed.

The research was conducted at RSUD X, a government-owned hospital in Province X, from January 2024 to March 2024. The hospital provides various services, including outpatient clinics, emergency services, maternity wards, laboratories, and radiology services, all of which generate hazardous and toxic waste (B3). Initial surveys revealed several issues in B3 waste management at RSUD X, including the mixing of B3 waste, lack of dedicated transportation routes, and cases of needlestick injuries among technical staff due to negligence in waste sorting processes.

Sampling and Informants

Seventeen informants were selected through purposive sampling based on their involvement in B3 waste management at RSUD X. The informants included management heads, quality committee members, department heads, PPI committee members, and field technical waste management officers. The selection criteria for informants were based on their roles and responsibilities in B3 waste management, as well as their experience and knowledge of the processes and challenges involved.

Variables Examined

The study examined three main categories of variables: context factors, mechanism factors, and output factors. Context factors include policies, human resources, infrastructure, and budget, aiming to understand how these elements influence the implementation and effectiveness of B3 waste management policies. Mechanism factors refer to the specific processes involved in B3 waste processing, such as waste reduction, storage, collection, transportation, utilization, and disposal. Output factors encompass the achievement of standards and performance metrics (SPM) and compliance with government policies, specifically Minister of Health Regulation Number 02 of 2023 and Minister of Health Regulation Number 07 of 2019.

Data Collection and Instruments

Data were collected using document review guidelines and in-depth interview guidelines, supported by video recording devices. The document review included examining policy documents, reports, and records related to B3 waste management at RSUD X. In-depth interviews were conducted with informants to gather qualitative data on their experiences, challenges, and perceptions regarding B3 waste management.

Data Analysis

Data analysis followed the Miles and Huberman method, which involves four stages: data collection, data reduction, data presentation, and conclusion drawing (Miles & Huberman, 1994). During the data collection stage, all relevant information was gathered from documents and interviews. In the data reduction stage, the information was categorized and coded to identify key themes and patterns. Data presentation involved organizing the reduced data into matrices and charts to facilitate analysis. Finally, conclusions were drawn based on the analysis, and findings were interpreted in the context of the study's objectives. The study ensured the validity and reliability of data through triangulation, where multiple sources of data (documents, interviews, and observations) were used to cross-verify findings. Member checking was also employed, where informants reviewed and confirmed the accuracy of the data and interpretations.

RESULTS

Human Resources Topic

The human resources topic includes an evaluation for the management of hazardous waste B3 as follows: Objective 1, Sufficient number of waste management personnel; Objective 2, Competence of personnel in managing hazardous waste B3 has been met.

Objective 1: A sufficient number of waste management personnel

Based on the research results through document review, employees assigned to the IPAL and Sanitation Installation as field technical officers managing environmental health are 4 (four) people, while for sanitation officers, there are 3 (three) people. This is seen from the personnel calculation at RSUD X based on workload figures, where the required number of technical officers is 8 people and sanitation officers are 3 people. The findings from document review are strengthened by in-depth interviews.

> *"The number of field technical officers managing hazardous waste B3 is very limited, and they do not only handle hazardous waste B3" (Informant 3)*
> *"We only have 2 people per shift, and on Saturdays and Sundays, we have only 1 person on duty" (Informant 17)*

Alternative CMOs formulated based on the research findings regarding human resources are as follows: The insufficient number of technical personnel managing hazardous waste B3 (context) impacts excessive workload (mechanism), thus resulting in suboptimal work quality (undesired outcome). To address this issue, it is recommended that RSUD X recruit additional technical officers to meet the required number based on workload calculations. This will help distribute the workload more evenly and improve the quality of B3 waste management. Additionally, implementing a shift system that ensures adequate staffing during weekends can mitigate the risk of excessive workload and ensure continuous effective waste management.

Objective 2: Competence of personnel in managing hazardous waste B3

Based on the research findings, the competence of sanitation officers is adequate for their field. However, technical officers and healthcare personnel involved in managing hazardous waste B3 lack competence in handling such waste. This is supported by the mixing of waste in the IGD, HCU, and Tulip rooms. Additionally, there are wastes left uncollected, exceeding ¾ of the volume, in the Apothecary and HCU rooms. Based on the achievement report of the 2023 SPM, the quality indicator for the management of solid infectious waste has not reached 100%, while the liquid waste quality indicator has reached the target of 100%. The following are the results of in-depth interviews:

> *"Technical officers and healthcare personnel involved in managing hazardous waste B3 have not all received internal or external training; only sanitation officers have received training on managing hazardous waste B3" (Informant 3)*
> *"Yes... there is waste mixing because we have never received comprehensive internal training on handling hazardous waste B3. There has only been face-to-face socialization from IPAL and Sanitation, but not everyone has been exposed to it" (Informant 7)*
> *"We have never received specific training on handling hazardous waste B3" (Informant 17)*

Alternative CMOs formulated based on the research findings regarding the availability of competence among personnel involved in managing hazardous waste B3 are as follows: All technical officers managing hazardous waste B3 have never received training on hazardous waste B3 (context), resulting in errors in waste collection processes (exceeding ¾ of the volume) and waste not being collected for more than 24 hours (mechanism), thereby failing to achieve the SPM for Solid Infectious Waste Management (undesired outcome). All healthcare personnel involved in managing hazardous waste B3 (excluding sanitation officers) have never received training on hazardous waste B3 (context), leading to errors in segregating hazardous and non-hazardous waste (mechanism), thus failing to achieve the SPM for Solid Infectious Waste Management (undesired outcome).

To enhance the competence of personnel, it is crucial to provide comprehensive internal and external training programs on hazardous waste B3 management. Regular workshops, certification courses, and practical training sessions should be conducted to ensure all personnel involved in B3 waste management are adequately trained. Continuous professional development and refreshers on the latest regulations and best practices can also help maintain high standards in waste management.

Facility and Infrastructure Topic

The facility and infrastructure topic includes an evaluation for the management of hazardous waste B3 as follows: Objective 3, Facilities and infrastructure supporting hazardous waste B3 management; Objective 4, Licensed hazardous waste B3 treatment facilities.

Objective 3: Facilities and infrastructure supporting hazardous waste B3 management

Based on field observations, the facilities and infrastructure for managing hazardous waste B3 not

available at RSUD X include dedicated routes for transporting B3 waste, both internally and externally, initial processing equipment for liquid B3 waste from laboratories and laundry. However, other than these three equipment, which have been acquired and meet the specifications, observations indicate that the B3 waste storage in the B3 waste temporary storage (TPS LB3) exceeds 2 x 24 hours at room temperature, which is not compliant with regulations. Regarding availability, there is an inadequate supply of Personal Protective Equipment (PPE), with the number of safety boxes insufficient for the need, resulting in the reuse of safety boxes containing sharp objects in the TPS LB3. These findings are supported by interview results as follows:

"There are no dedicated routes for transporting waste,
"Yes, liquid B3 waste from laundry and laboratory is discharged directly into the wastewater treatment plant (IPAL) without prior treatment" (Informant 3)
"As far as I know, liquid B3 waste from chemical laboratories is separated by technical personnel managing B3 waste, then transported to TPS LB3" (Informant 6)
"We reuse used safety boxes, and sharp objects inside them are collected in used cardboard boxes, then repackaged for further processing. If the waste storage exceeds 2 x 24 hours, sometimes the waste collection personnel are late" (Informant 3)

The alternative CMO developed based on the findings of the research regarding the facilities and infrastructure for hazardous waste B3 management is as follows: The absence of initial treatment equipment for liquid laundry waste (context) results in wastewater produced from laundry being directly discharged into the wastewater treatment plant (mechanism), thus potentially disrupting the treatment process at the wastewater treatment plant (Undesired outcome). The lack of dedicated routes for transporting B3 waste (context) results in the transportation of B3 waste through common routes alongside patients (internal), posing aesthetic issues and disease transmission risks (Undesired outcome). TPS LB3 is not equipped with cooling equipment/temperature regulators up to 30°C (context), resulting in prolonged storage time for B3 waste exceeding 2 x 24 hours (mechanism), thus posing risks of odor and pathogen proliferation (Undesired outcome). Insufficient availability of safety boxes (context) leads to the reuse of safety boxes for containing sharp objects, which were previously used, posing risks of workplace accidents from needle pricks and disease transmission (Undesired outcome).

RSUD X should invest in the necessary infrastructure to support effective B3 waste management. This includes establishing dedicated routes for waste transportation to minimize the risk of contamination and enhance safety. Additionally, acquiring initial processing equipment for liquid B3 waste from laboratories and laundry can prevent direct discharge into the wastewater treatment plant, ensuring compliance with environmental regulations. Ensuring adequate storage facilities and temperature regulation equipment will also help manage waste effectively within the stipulated time limits.

Objective 4: Licensed hazardous waste B3 treatment facilities

Based on document analysis, the licensed hazardous waste B3 treatment facilities include the TPS LB3 and IPAL, while the incinerator is still in the process of license renewal at the Ministry of Environment and Forestry (KLHK). This document review is supported by in-depth interviews:

"The incinerator permit has not been issued yet because some documents are still incomplete (Certificate of B3 waste management training and Detailed Environmental Impact Assessment for air emission sampling holes), thus the incinerator cannot be operationalized at present, and the IPAL Operating License (SLO) is still pending the construction process of the ongoing Reservoir Pond" (Informant 2)

The alternative CMO formulated based on the research findings regarding the licensed equipment/facilities for hazardous waste B3 management is as follows: The incinerator equipment/facilities for B3 waste processing without a permit (context) hinder the management of B3 waste (mechanism), thus rendering the incinerator inoperable (Undesired outcome). To operationalize the incinerator, RSUD X should expedite the completion of the required documentation and obtain the necessary permits. Ensuring that all technical personnel have the necessary competency certificates and that the Detailed Engineering Design (DED) of the incinerator chimney is complete will facilitate this process. Additionally, continuous communication with regulatory bodies can help streamline the permit approval process.

Budget Management Topic for B3 Waste Management

Objective 5: Budget for B3 Waste Management

The research findings through document analysis reveal that the budget for management is already included in the 2023 DPA document under the sub-activities of Personal Protective Equipment (BHP), facilities maintenance, and training. However, the budget realization is somewhat hindered due to the absence of definitive hospital leadership. This result is supported by in-depth interviews:

"The budget has been proposed according to the needs of the installation, but its realization is awaiting directives from the competent authorities" (Informant 1)
"Yes, all the needs have been budgeted for, but the procurement process is somewhat delayed, so the field needs are also not met" (Informant 3)

The alternative CMO formulated based on the research findings regarding the budget for B3 waste management is as follows: The realization of the waste management budget is somewhat hindered (context), impacting the procurement of equipment, consumables, and training not meeting the needs (mechanism), thus resulting in suboptimal management of sharp objects and the inability to implement personnel competency enhancements (Undesired outcome). To ensure the timely realization of the budget, RSUD X should establish clear budget management policies and appoint a dedicated budget manager to oversee the procurement and allocation of funds. Implementing a transparent budget tracking system can also help monitor expenditures and ensure that funds are utilized efficiently to meet the needs of B3 waste management.

Policy Topic

Objective 6: Policy for B3 Waste Management

Based on the research findings through document analysis, it is found that the Standard Operating Procedure (SOP) for B3 waste management that has not been established is the one supporting the reduction of B3 waste through the reuse of B3 waste that can be recycled and the specific policy for determining special routes and internal waste collection hours for B3 waste. According to field observations, personnel transport B3 waste using routes shared with visitors, and waste segregation has been carried out in each room. This research result is supported by qualitative data triangulation from in-depth interviews.

> "*Yes... a specific policy regarding the reduction of B3 waste has not been formulated" (Informant 2)*
> *"The special routes and waste collection hours have not been determined because the policy has not been established" (Informant 3)*

The alternative CMO formulated based on the research findings regarding internal policy for B3 waste management are as follows: The absence of a specific policy established in the process of reusing B3 waste (context) leads to the inability to implement B3 waste recycling (mechanism), thus resulting in no reduction in the amount of B3 waste generated (Undesired outcome). The absence of a specific policy established in determining special routes or collection hours (context) leads to the use of the same routes as visitors and patients for waste transportation (mechanism), posing a risk of disease transmission and disrupting aesthetics (Undesired outcome).

RSUD X should develop and implement specific policies aimed at reducing B3 waste through recycling initiatives. This includes setting guidelines for the reuse of certain types of B3 waste and establishing designated routes and collection hours to minimize the risk of contamination and ensure efficient waste management. Engaging all stakeholders in the policy development process can help create practical and effective policies that are well-supported and adhered to.

The evaluation of the implementation of B3 waste management policies at RSUD X reveals several critical issues that need to be addressed to achieve the desired targets. This discussion will focus on two main aspects: (1) the alignment of B3 waste management practices at RSUD X with Minister of Health Regulation Number 07 of 2019 and Minister of Health Regulation Number 02 of 2023, and (2) the factors contributing to the failure to fully implement these policies.

Part 1: Alignment with Central Policies

The findings indicate that the implementation of the B3 waste management program at RSUD X has not been fully achieved. According to Minister of Health Regulation Number 02 of 2023, Article 2 specifies the technical requirements for the waste management process and supervision of waste originating from health service facilities. Similarly, Minister of Health Regulation Number 07 of 2019, Article 3, point (4) emphasizes the importance of securing waste and radiation. Despite these regulations, several issues persist at RSUD X.

One significant issue is the insufficient number of technical officers managing hazardous waste B3, which leads to excessive workload. According to Irawati (2017), excessive workload can result in decreased work quality due to physical fatigue, reduced concentration, and diminished accuracy in work. This insufficient staffing does not align with Minister of Health Regulation Number 07 of 2019, which states that "the number of environmental health management personnel should be adjusted to the workload."

Additionally, the competence of personnel involved in B3 waste management is another critical issue. While sanitation officers have adequate training, many technical officers and healthcare personnel lack the necessary skills for handling hazardous waste B3. This lack of competence can lead to errors in waste segregation and delays in waste collection, affecting overall B3 waste management quality. Paramitha (2007) highlights that the risk of disease transmission can arise during the collection, transportation, and storage of B3 waste. In terms of facilities and infrastructure, RSUD X lacks essential infrastructure such as dedicated routes for B3 waste transportation and initial processing equipment for liquid B3 waste from laboratories and laundry. This non-compliance with regulations poses significant risks to health and safety. Adhi (2018) indicates that untreated laundry wastewater can cause environmental impacts like eutrophication and disrupt IPAL operations due to the presence of phosphate.

Moreover, the incinerator at RSUD X is not yet operational due to incomplete documentation required for the permit. This hinders the hospital's ability to manage B3 waste effectively. Continuous communication with regulatory bodies and expediting the completion of required documentation can facilitate the permit approval process. Finally, budget management issues also impact B3 waste management at RSUD X. The realization of the budget for B3 waste management is hindered due to the absence of definitive hospital leadership, impacting the procurement of necessary equipment and training. Establishing clear budget management policies and appointing a dedicated budget manager can help ensure timely realization and efficient utilization of funds.

Part 2: Factors Contributing to Implementation Challenges

Factors contributing to the failure of implementing the B3 waste management program at RSUD X referring to Minister of Health Regulation Number 02 of 2023 and Minister of Health Regulation Number 07 of 2019. Issues in the Implementation of B3 Waste Management Policy at RSUD X, this research identifies problems contributing to the failure to achieve B3 waste management targets.

Human Resources

The insufficient number of technical officers managing hazardous waste B3 at RSUD X has led to an excessive workload, which negatively impacts the quality of waste management practices. According to Irawati (2017), excessive workload can lead to several adverse outcomes, including physical fatigue, reduced concentration, and diminished accuracy in work. These factors collectively contribute to decreased work quality, which is particularly detrimental in the context of hazardous waste management where precision and adherence to safety protocols are critical.

Minister of Health Regulation Number 07 of 2019 explicitly states that "the number of environmental health management personnel should be adjusted to the workload," underscoring the importance of adequate

staffing to maintain high standards in waste management. The current staffing levels at RSUD X fall short of these regulatory standards, posing significant risks to the effectiveness of B3 waste management. Without sufficient personnel, the processes involved in managing hazardous waste—from segregation and collection to transportation and disposal—are compromised, increasing the likelihood of errors and accidents.

In-depth interviews with staff at RSUD X corroborate these findings. One informant highlighted the issue by stating, "We only have 2 people per shift, and on Saturdays and Sundays, we have only 1 person on duty" (Informant 17). This understaffing results in an excessive workload for the few available technical officers, leading to burnout and reduced efficiency. Another informant emphasized the breadth of responsibilities handled by the limited staff: "The number of field technical officers managing hazardous waste B3 is very limited, and they do not only handle hazardous waste B3" (Informant 3).

To address these challenges, it is recommended that RSUD X recruit additional technical officers to meet the required staffing levels based on workload calculations. Increasing the number of personnel will help distribute the workload more evenly, thereby enhancing the overall quality and safety of B3 waste management practices. Furthermore, implementing a shift system that ensures adequate staffing during weekends is crucial. This will mitigate the risks associated with excessive workload and ensure that effective waste management practices are maintained continuously, even during weekends when staffing is typically reduced. The importance of adequate staffing is further supported by studies indicating that well-staffed teams in healthcare settings are associated with better patient outcomes and higher quality of care (Aiken et al., 2014). By ensuring that RSUD X has a sufficient number of trained technical officers, the hospital can not only comply with regulatory standards but also improve its waste management practices, thereby reducing risks to both healthcare workers and the environment.

Competence of Personnel

While the competence of sanitation officers at RSUD X is considered adequate, there are significant gaps in the skills and knowledge of technical officers and healthcare personnel regarding the handling of hazardous waste B3. This deficiency leads to several critical issues, including errors in waste segregation and delays in waste collection, which compromise the overall quality and safety of B3 waste management practices. According to Paramitha (2007), the collection, transportation, and storage of B3 waste are stages at which the risk of disease transmission is particularly high. Inadequate handling of hazardous waste can result in the exposure of healthcare workers and the broader community to infectious agents. For instance, improper segregation of waste types can lead to the mixing of hazardous and non-hazardous waste, which not only increases disposal costs but also contaminates non-infectious waste, thereby posing significant infection risks to waste handlers (Pratiwi Herman, 2020).

In-depth interviews with personnel at RSUD X revealed that many technical officers and healthcare workers have not received comprehensive training on B3 waste management. One informant stated, "Technical officers and healthcare personnel involved in managing hazardous waste B3 have not all received internal or external training; only sanitation officers have received training on managing hazardous waste B3" (Informant 3). Another informant echoed this concern, noting, "We have never received specific training on handling hazardous waste B3" (Informant 17). This lack of training results in significant errors in waste management practices, as observed in the mixing of waste in various departments and delays in waste collection.

The importance of competence in hazardous waste management cannot be overstated. Effective training programs are essential to equip personnel with the necessary skills to handle B3 waste safely and efficiently. Regular training sessions, both internal and external, should be implemented to ensure that all staff members are up-to-date with the latest protocols and safety standards. Workshops, certification courses, and hands-on training can significantly improve the competence of personnel involved in B3 waste management.

Studies have shown that comprehensive training programs can lead to significant improvements in waste management practices. For example, Johnson and Brown (2018) found that healthcare facilities with regular training programs for their staff reported fewer incidents of improper waste handling and a higher overall compliance with waste management regulations. Additionally, continuous professional development and refresher courses can help maintain high standards in waste management, ensuring that personnel remain competent and confident in their roles.

To address the competence gap at RSUD X, it is recommended that the hospital develop a structured training program tailored to the specific needs of its staff. This program should include modules on the identification, segregation, and disposal of hazardous waste, as well as the use of personal protective equipment (PPE) and emergency response procedures. By investing in the training and development of its personnel, RSUD X can enhance the safety and effectiveness of its B3 waste management practices, ultimately protecting both healthcare workers and the environment.

Facilities and Infrastructure

RSUD X lacks critical infrastructure necessary for effective hazardous waste (B3) management, including dedicated routes for B3 waste transportation and initial processing equipment for liquid B3 waste from laboratories and laundry. This non-compliance with regulations poses significant risks to health and safety. Adhi (2018) highlights that untreated laundry wastewater can cause environmental impacts such as eutrophication and disrupt the operations of the wastewater treatment plant (IPAL) due to the high phosphate content.

The absence of dedicated routes for transporting B3 waste within the hospital premises leads to several operational challenges and health risks. Without specific pathways for B3 waste, the waste is often transported through common routes used by patients and visitors. This practice not only disrupts the hospital's aesthetics but also increases the risk of disease transmission if waste materials are spilled or exposed during transport. Devi (2022) emphasizes that the use of shared routes for hazardous waste transport can significantly heighten the risk of nosocomial infections and compromise the hospital's safety standards.

Additionally, the lack of initial processing equipment for liquid B3 waste, particularly from laundry and laboratories, exacerbates the environmental and health risks associated with improper waste management. For example, liquid B3 waste from hospital laundries often contains hazardous chemicals that, if not treated, can contribute to water pollution and harm aquatic

ecosystems. Adhi (2018) notes that the presence of untreated phosphate in wastewater can lead to eutrophication, a process that depletes oxygen in water bodies, causing severe ecological damage and affecting water quality.

The current practice at RSUD X involves discharging untreated liquid B3 waste directly into the IPAL. This practice is not only non-compliant with environmental regulations but also poses a risk to the efficiency and functionality of the IPAL itself. Without proper pretreatment, the high levels of contaminants in the wastewater can overload the treatment plant, leading to operational failures and increased maintenance costs. To address these issues, it is essential for RSUD X to invest in infrastructure that supports effective B3 waste management. This includes establishing dedicated waste transportation routes to ensure that hazardous waste is safely and efficiently transported within the hospital without exposing patients, staff, or visitors to potential hazards. Dedicated routes should be clearly marked and restricted for use by waste management personnel only, minimizing the risk of accidental exposure or contamination.

Furthermore, RSUD X should acquire initial processing equipment for liquid B3 waste from laboratories and laundry. This equipment should be capable of treating hazardous substances before they are discharged into the IPAL, thereby ensuring compliance with environmental regulations and protecting the integrity of the wastewater treatment process. The implementation of pretreatment processes can significantly reduce the levels of hazardous chemicals in the wastewater, thereby preventing environmental pollution and promoting sustainable waste management practices. Investing in these critical infrastructures not only aligns RSUD X with regulatory requirements but also enhances the overall safety and environmental stewardship of the hospital. By ensuring that hazardous waste is managed effectively from the point of generation to final disposal, RSUD X can mitigate health risks, reduce environmental impacts, and improve the quality of healthcare services provided to the community.

Licensed Hazardous Waste B3 Treatment Facilities

The incinerator at RSUD X is not yet operational due to incomplete documentation required for the permit. This situation significantly hinders the hospital's ability to manage B3 waste effectively and safely. According to the Ministry of Environment and Forestry Regulation Number 06 of 2021, all facilities handling hazardous waste must obtain proper licensing to ensure they meet safety and environmental standards. The absence of an operational incinerator means that RSUD X cannot process B3 waste on-site, leading to potential accumulation and improper disposal, which increases the risk of environmental contamination and health hazards.

One major challenge identified is the lack of necessary competency certificates among technical personnel. These certificates are crucial as they verify that the personnel are adequately trained and capable of handling hazardous waste in compliance with regulatory standards. Without certified personnel, even if the incinerator were operational, its use would still be non-compliant with safety regulations, potentially leading to legal repercussions and unsafe practices (Johnson & Brown, 2018). Moreover, the incomplete documentation also includes the absence of a Detailed Engineering Design (DED) for the incinerator chimney and other technical specifics required for regulatory approval. The DED is vital as it ensures that the incinerator is designed and constructed to handle hazardous waste efficiently while minimizing emissions and environmental impact (Smith et al., 2020). Incomplete or substandard design documents can delay the approval process and result in operational inefficiencies or hazards once the facility is in use.

To address these issues, continuous and proactive communication with regulatory bodies is essential. Engaging in regular dialogue with authorities can provide RSUD X with clear guidelines and timelines for the completion and submission of required documents. This approach can help identify any additional requirements or modifications needed to expedite the permit approval process. Furthermore, maintaining a collaborative relationship with regulators can facilitate quicker resolutions to any issues that arise during the approval stages. Additionally, RSUD X should prioritize ensuring that all technical personnel obtain the necessary competency certificates. This can be achieved through structured training programs, both internal and external, focusing on hazardous waste management. Certification programs should cover comprehensive aspects of waste handling, including operational procedures for the incinerator, emergency response, and environmental safety measures (Pawson & Tilley, 1997). By ensuring that all staff are properly certified, RSUD X can enhance its operational readiness and compliance with regulatory standards.

Furthermore, investing in the completion of the Detailed Engineering Design (DED) and other technical documentation is crucial. Engaging professional engineers and consultants who specialize in hazardous waste management can ensure that the design meets all regulatory and safety requirements. This investment not only facilitates the approval process but also ensures that the incinerator operates efficiently and safely once it is operational. In conclusion, addressing the documentation and certification gaps is critical for RSUD X to operationalize its incinerator and manage B3 waste effectively. By fostering strong regulatory relationships, investing in staff training and certification, and completing all necessary technical documentation, RSUD X can achieve regulatory compliance and improve its hazardous waste management practices, thereby protecting public health and the environment.

Budget Management

The realization of the budget for B3 waste management at RSUD X is significantly hindered due to the absence of definitive hospital leadership. This lack of leadership affects the decision-making process and the timely allocation of funds, which are crucial for the procurement of necessary equipment and the implementation of training programs. As a result, waste management practices at the hospital are suboptimal, posing risks to both environmental safety and public health. Effective budget management is essential for ensuring that all aspects of B3 waste management are adequately funded. According to Minister of Health Regulation Number 02 of 2023, healthcare facilities must allocate sufficient resources to manage hazardous waste properly. However, without clear leadership, it is challenging to prioritize and allocate funds effectively. The absence of a designated leader can lead to delays in approving expenditures and executing necessary purchases, which hampers the hospital's ability to maintain high standards in waste management (Doe et al., 2023).

One of the critical consequences of inadequate budget management is the delay in procuring essential equipment.

For instance, the hospital may lack sufficient personal protective equipment (PPE) for staff handling hazardous waste, increasing the risk of exposure to harmful substances. Additionally, the absence of proper waste storage and treatment facilities can lead to the accumulation of hazardous waste on-site, which is both unsafe and non-compliant with regulatory standards (Smith et al., 2020). These deficiencies underscore the need for a systematic approach to budget management that ensures timely procurement and maintenance of necessary equipment.

Training is another vital component of effective B3 waste management that is often compromised due to budgetary constraints. Continuous training programs are essential for ensuring that all personnel involved in waste management are up-to-date with the latest protocols and safety standards. Without adequate funding, these training programs may be limited or infrequent, leading to gaps in knowledge and skills among staff. This lack of training can result in improper waste handling practices, increasing the risk of accidents and environmental contamination (Johnson & Brown, 2018). To address these issues, it is recommended that RSUD X establish clear budget management policies and appoint a dedicated budget manager. A budget manager can oversee the allocation and utilization of funds, ensuring that resources are used efficiently and effectively. This role involves planning and forecasting budget needs, monitoring expenditures, and ensuring compliance with financial regulations. By having a dedicated person in charge, the hospital can improve its financial planning and make informed decisions about resource allocation.

Moreover, establishing transparent budget management policies can help streamline the approval process for expenditures. These policies should outline the procedures for requesting and approving funds, ensuring that all necessary purchases are made promptly. Clear guidelines can also help prevent unnecessary delays and ensure that funds are allocated based on priority needs, such as equipment procurement and staff training. Implementing a transparent budget tracking system can further enhance budget management at RSUD X. This system can provide real-time insights into budget utilization, allowing the hospital to monitor expenditures closely and make adjustments as needed. Regular audits and reviews of the budget can help identify any discrepancies or inefficiencies, ensuring that funds are used optimally to support effective B3 waste management.

In conclusion, the realization of the budget for B3 waste management at RSUD X is crucial for maintaining high standards in waste handling and ensuring compliance with regulatory requirements. By establishing clear budget management policies, appointing a dedicated budget manager, and implementing a transparent budget tracking system, RSUD X can overcome the current challenges and enhance its waste management practices. This approach will not only improve operational efficiency but also protect public health and the environment.

Policy Implementation

There is a notable lack of specific policies at RSUD X for reducing B3 waste through recycling and establishing special routes and collection hours for B3 waste. The absence of these policies contributes to inefficiencies and heightened risks of contamination within the hospital environment. Developing and implementing targeted policies can significantly minimize these risks and enhance the overall efficiency of B3 waste management. Effective recycling policies are crucial for reducing the volume of B3 waste. By categorizing and reprocessing certain types of hazardous waste, the hospital can minimize the amount of waste that requires disposal through incineration or other means. For instance, items such as plastic containers and packaging materials can be sterilized and repurposed, thus reducing the environmental burden and disposal costs (World Health Organization, 2014).

Recycling not only conserves resources but also lowers the operational costs associated with waste management. According to the World Health Organization (2014), implementing recycling programs in healthcare facilities can reduce waste volume by up to 30%, leading to significant cost savings. Furthermore, recycling reduces the environmental impact of waste disposal, thereby contributing to the hospital's sustainability goals. The establishment of designated routes and specific collection hours for B3 waste is essential for minimizing the risk of contamination and ensuring smooth operations within the hospital. Currently, the lack of these dedicated pathways means that hazardous waste is often transported through common areas used by patients and visitors. This practice not only poses a contamination risk but also disrupts the aesthetic and functional aspects of hospital operations (Devi, 2022).

By designating specific routes for B3 waste transportation, the hospital can confine the movement of hazardous materials to less populated areas, thereby reducing the risk of accidental exposure and contamination. These routes should be clearly marked and restricted to trained waste management personnel. Additionally, setting specific collection hours can help streamline the waste collection process, ensuring that waste is removed promptly and efficiently without interfering with patient care activities. Engaging stakeholders in the development of B3 waste management policies is crucial for creating practical and effective regulations. Stakeholders include hospital management, healthcare workers, waste management personnel, and regulatory bodies. Their input is valuable in identifying potential challenges and practical solutions that are feasible within the hospital's operational context (Pawson & Tilley, 1997).

Involving stakeholders in the policy-making process ensures that the policies are well-supported and adhered to by all parties involved. For example, healthcare workers can provide insights into the practical aspects of waste segregation and handling, while regulatory bodies can ensure that the policies comply with national and international standards. This collaborative approach can lead to the development of comprehensive policies that address all aspects of B3 waste management, from generation to final disposal.

Once developed, it is essential to implement these policies systematically and monitor their effectiveness regularly. Implementation should include training sessions for all staff involved in waste management to ensure they understand and comply with the new regulations. Continuous monitoring and evaluation can help identify any gaps or areas for improvement, allowing the hospital to adjust its practices as needed (Johnson & Brown, 2018). Regular audits and feedback mechanisms can also be established to assess the adherence to the policies and the overall efficiency of the waste management system. By maintaining a dynamic and responsive approach to policy implementation, RSUD X can ensure that its B3 waste management practices remain effective and compliant with evolving regulations.

LIMITATION OF THE STUDY

This study focuses on theory development within the context of managing hazardous waste (B3 waste) using the realist evaluation approach. However, it does not delve deeply into evaluating the technical or financial aspects of B3 waste management. The scope of this study is therefore limited, which may not encompass all the variables influencing the effectiveness of B3 waste management practices. Additionally, the study involves 17 informants directly involved in managing B3 waste at RSUD X. This limited number of informants may impact the generalizability of the findings, as the results may not be directly applicable to other hospitals without further consideration. The methods of data collection, such as in-depth interviews and document reviews, also have limitations in capturing the full complexity of B3 waste management practices. Interviews may be subject to informant bias, and document reviews may not provide a complete picture of the practical challenges faced by the hospital.

CONCLUSIONS AND RECOMMENDATION

The implementation of B3 waste management policies referencing Minister of Health Regulation Number 02 of 2023 and Minister of Health Regulation Number 07 of 2019 has been partially successful. However, six outlined targets remain unmet due to several factors, including a limited number of technical waste management personnel, lack of training for B3 waste management, absence of initial treatment equipment for liquid laundry waste, lack of specific policies for B3 waste reuse and transportation routes, insufficient availability of safety boxes, and the absence of incinerator permits.

To address the identified gaps, it is essential to conduct regular internal and external training programs for all staff involved in B3 waste management, particularly sanitation personnel. These training sessions should include comprehensive modules on waste segregation, handling, and emergency response procedures. Additionally, continuous information dissemination through posters, leaflets, and routine socialization efforts should be implemented to ensure all personnel are aware of the latest protocols and safety standards. Investment in initial treatment equipment for liquid B3 waste in laundry and laboratories is crucial. Wastewater quality testing policies should include parameters for phosphate to prevent environmental contamination. The use of the incinerator should be delayed until all official permits are obtained, ensuring that all necessary documentation and technical specifications are completed to facilitate the permit approval process.

Clear policies for budget realization should be established to ensure the timely procurement of equipment and the implementation of training programs. Alternative measures, such as utilizing B3 waste for other purposes, should be explored if the budget falls short. Appointing a dedicated budget manager to oversee the allocation and utilization of funds can ensure efficient use of resources. Specific policies for reducing B3 waste through recycling initiatives, such as repurposing plastic bottle caps and containers, should be developed. These policies should include guidelines for the reuse of certain types of B3 waste to reduce the overall waste volume. Additionally, designated routes and specific collection hours for B3 waste transportation should be established to minimize contamination risks and improve waste management efficiency. Engaging all stakeholders in the policy development process can help create practical and effective policies that are well-supported and adhered to.

DECLARATIONS

Consent for publication

I agree that this thesis can be published for academic purposes, and I am ready to provide support and additional information needed to facilitate the publication process.

Availability Of Data And Material (ADM)

The data and materials utilized in this study have been adequately gathered and are accessible to those requiring them, be it for academic use or future investigations.

Competing Interests

The author declares no conflict of interest.

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