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Building Sustainable Hospital Waste Management through Financial Integration: A Multi-Level Approach at RSUD Arosuka, West Sumatra, Indonesia

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ABSTRACT

Hospital waste management performance has increasingly drawn public attention due to the generation of hazardous medical waste that can pollute the environment and endanger public health. However, previous studies in this area have rarely integrated the financial factor as a mediating variable linking the micro level (individual social responsibility), meso level (learning and growth), and macro level (audit) in hospital waste management performance. Finance serves as the foundation for providing infrastructure, facilities, and staff training. This study employs a quantitative approach using path analysis with the Partial Least Squares (PLS) method. The sample consists of 190 respondents selected purposively from a total population of 359 employees at RSUD Arosuka, based on their direct involvement in hospital waste management. The findings reveal that all variables have a positive and significant effect on waste management performance, both directly and through financial mediation. The study concludes that financial support strengthens the effectiveness of social responsibility, auditing, and learning processes in enhancing sustainable waste management. It recommends increasing environmental budget allocations, continuous staff training, and the regular implementation of both internal and external audits to achieve more efficient and sustainable hospital waste management systems.

Keywords: Individual social responsibility, Learning and growth, Audit, Finance, Hospital waste management performance.

INTRODUCTION

The performance of hospital waste management is now beginning to receive serious attention from various parties. (Berrachedi et al., 2024). This is because hospitals interact directly with various types of hazardous materials and produce waste that has the potential to pollute the environment. Therefore, hospitals are required to continuously improve the effectiveness and efficiency of their waste management. Menurut Mushtaq et al., (2022) Improper management of hospital waste can pose a major risk to patients, medical personnel, and the surrounding community, as exposure to these hazardous materials can cause serious health and environmental impacts. Hospitals produce hazardous medical waste that has the potential to pollute the environment and pose risks to public health. This is important because medical waste contains toxic substances and pathogens that can be transmitted to humans and animals. Improper management can pollute the soil, water, and air around the hospital environment. Menurut Kementerian Kesehatan, (2023), Hospitals in Indonesia generate approximately 366 tons of hazardous medical waste every dayData from the WHO (2022) also states that around 15% of total healthcare facility waste is classified as hazardous and can transmit infectious diseases. Research by LIPI (2021) shows that more than 30% of hospitals in Indonesia still do not have a medical waste management system that meets

environmental standards. Effective and standard-compliant hospital waste management is essential to prevent environmental pollution and protect public health. (Swamy et al., 2018).

The performance of hospital management in Indonesia is still not optimal and requires serious improvement so as not to endanger the environment and public health (Sunindijo et al., 2020). This is due to the low number of health facilities that meet medical waste management standards. In addition, limited infrastructure and lack of supervision mean that many hospitals are not yet able to manage their waste safely and in an environmentally friendly manner. Based on data from the Kementerian Kesehatan RI (2023), SIKELIM (2023), only 27% of health facilities in Indonesia have met medical waste management standards, despite an increase from 19% in 2023. The World Health Organization (2022) also emphasizes that improper medical waste management can increase the risk of infectious disease transmission by up to 20% in hospital environments. Furthermore, a report by LIPI (2021) shows that more than 30% of hospitals in Indonesia still do not have waste treatment facilities that meet environmental standards.

One of the provinces in Indonesia that faces the problem of suboptimal medical waste management is West Sumatra Province. This problem is reflected in a statement from the Kementerian lingkungan hidup republik Indonesia (2023), which states that the level of compliance of hotels and hospitals regarding pollution control is still far from expectations. This problem can also be seen in the news. One of the news reports related to medical waste management in the West Sumatra region is on news.republika.co.id, which essentially explains that several types of medical waste, such as IV tubes, syringes, bandages, and medicine boxes, have been found on Tan Sridano Beach, West Sumatra. This medical waste may have come from several hospitals, and one of the items found was a transfusion bag labeled with the name of a regional public hospital in West Sumatra. The medical waste scattered on this beach is very dangerous to the community, as many people have reported being pricked by syringes scattered on the beach, and these syringes may have been used on patients with infectious diseases.

Limitations in medical waste management also occur in West Sumatra Province, particularly in hospitals outside the Solok City area. Most regional hospitals do not yet have incinerators or adequate medical waste disposal facilities, resulting in suboptimal management and posing risks to the environment and public health (Nigrum et al., 2024). According to Majid (2024), limited operational budgets and weak supervision from relevant agencies have exacerbated the situation. Based on data, the total amount of hazardous medical waste produced by hospitals in West Sumatra reaches around 1,899.15 tons per year from 2,839 health facilities. However, because there is no medical waste treatment center in this region, all waste must be sent to Java at a high cost of around Rp20,000–Rp40,000 per kilogram. This condition shows that the medical waste management system in West Sumatra is still far from optimal and requires serious attention and collaboration between the local and central governments. Of the 12 districts in West Sumatra, Solok District is projected to have the highest volume of hazardous medical waste for the period 2019–2040, as shown in Figure 1.

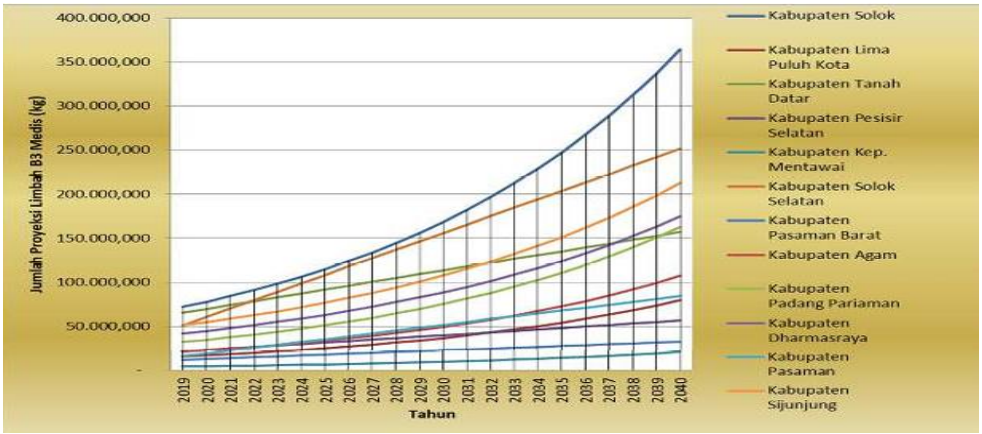

Figure 1. Projected Amount of Medical Hazardous Waste until 2040 in All Districts in West Sumatra Province.
Source: Data taken from the Andalas University Institute for Research and Community Service (2019) and reprocessed by the author.

Based on Figure 1.1, Solok Regency is estimated to be the region with the highest volume of medical hazardous waste in West Sumatra Province until 2040. In that year, the amount of medical hazardous waste is projected to reach approximately ±364,363.73 kilograms, equivalent to an average of ±1 ton per day. This increase in waste volume comes from various health care facilities operating in the Solok Regency area, with the Arosuka Regional General Hospital (RSUD) as the largest contributor. The high amount of waste indicates an increase in health care activities as well as a serious challenge in safe and environmentally friendly medical waste management. Therefore, a more effective and sustainable waste management system is needed to prevent negative impacts on the

environment and public health. More detailed information on the projected generation of medical hazardous waste at the Arosuka Regional General Hospital during the 2019–2040 period is shown in Figure 2.

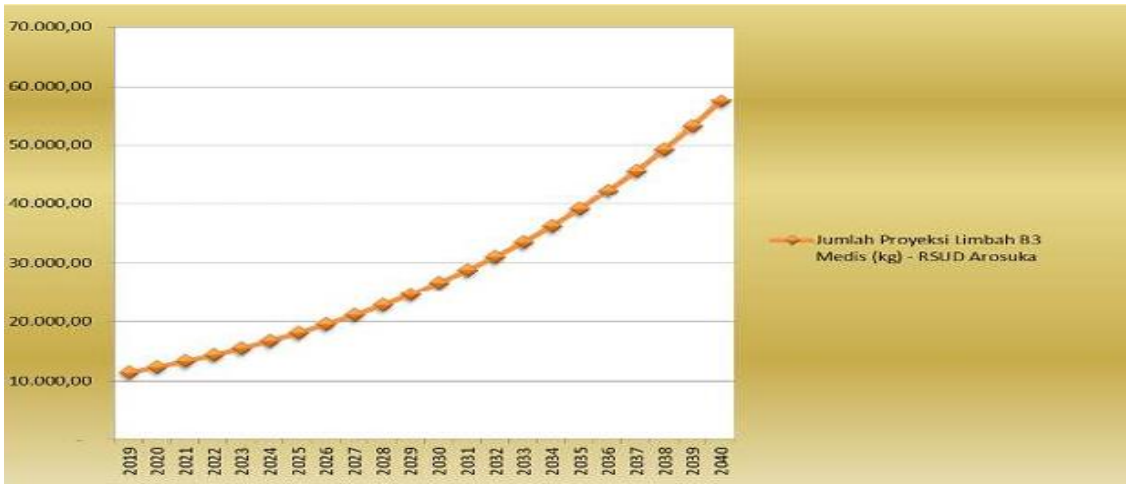

Figure 2. Projected Medical Hazardous Waste Generation at Arosuka Regional General Hospital from 2019 to 2040.
Source: Data taken from the Andalas University Institute for Research and Community Service (2019) and reprocessed by the author.

Based on Figure 1.2, the projection data shows that the volume of medical hazardous waste at Arosuka Regional General Hospital continues to increase from year to year. This growth trend is also in line with historical data on medical hazardous waste generated at the hospital. Based on the Arosuka Regional General Hospital report, the amount of medical hazardous waste produced in the 2019 to 2022 period was 7,866 kg, 8,275 kg, 12,295 kg, and 14,484 kg, respectively. This data shows a significant increase each year, both from actual records and based on future projections. One of the serious environmental problems occurring in West Sumatra Province was reported by sumbartoday.co.id, which revealed allegations of the use of polluted river water by Arosuka Regional General Hospital (Ridwan, 2020). The hospital is suspected of using water from a small river in the area that has been contaminated with waste. If it is true that the polluted water is being used without undergoing proper treatment, then this situation has the potential to pose a danger to patients, medical personnel, and the surrounding community.

To address these issues, a comprehensive approach is needed to improve hospital waste management performance, particularly in the area of hazardous medical waste management. This approach includes the implementation of environmentally friendly waste treatment systems, improving human resource competencies in hazardous waste management, and strict supervision of the implementation of environmental standard operating procedures (SOPs) (Quttainah & Singh, 2024). In addition, collaboration between local governments, hospitals, and environmental monitoring agencies is also very important to ensure that every stage of waste management is carried out safely and in accordance with the provisions of laws and regulations. These efforts are expected to minimize negative impacts on the environment and improve the quality of sustainable health services in Solok Regency.

According to Amos (2023), an approach that involves three levels of analysis—micro, meso, and macro—is essential to address the complexity of hospital waste management issues. At the micro level, the concept of Individual Social Responsibility (ISR) serves as a fundamental basis for building an environmentally conscious organizational culture within hospitals. In line with Grose et al. (2012), ISR reflects the awareness and responsibility of every individual, including medical staff, non-medical employees, and visitors, to actively participate in safe and sustainable waste management practices. Research by Cho et al. (2024) found that simple actions such as sorting waste according to its category, avoiding the disposal of medical waste into general bins, and adhering to operational standards represent concrete forms of ISR in preventing environmental pollution and the spread of disease. Furthermore, Jungbluth et al. (2024) and Kwesiga et al. (2017) emphasized that hospitals that successfully embed ISR values demonstrate higher compliance with environmental regulations and foster a healthier and safer working environment.

At the meso level, the improvement of hospital waste management performance is largely determined by the effectiveness of services and the integration of internal operational management with organizational learning and growth (Garrot et al., 2021). Myung et al. (2019) argue that the learning and growth dimension, as one of the key pillars of the Balanced Scorecard, promotes innovation, human resource competence, and adaptability to changes in management systems. In the hospital context, improved waste management performance depends on the institution's ability to build a culture of continuous learning through training, technical capacity building, and the

adoption of environmentally friendly technologies. Perlman (2023) reported that regular training on waste segregation and handling increased compliance among healthcare workers by up to 87%. Similarly, Kumar et al. (2024) confirmed that hospitals implementing learning-based management systems achieved higher operational efficiency and reduced contamination risks. Thus, investment in learning and growth is crucial to developing a sustainable and adaptive hospital waste management system.

Furthermore, at the macro level, audits play an important role as an instrument for monitoring and evaluating hospital compliance in medical waste management (Tabrizi et al., 2019). These audits not only ensure that each hospital complies with government standards and regulations, but also serve as a means of assessing the effectiveness of policies and identifying gaps in waste management implementation. According to research conducted by Eslami et al. (2017), the implementation of periodic environmental audits can increase hospital compliance with waste management standards by up to 75% in two years. Additionally, a study by RISKESDAS (2023) also shows that hospitals that consistently conduct external audits tend to have more efficient, transparent, and environmentally friendly waste management systems. Audits serve as a strategic control mechanism that not only promotes accountability in healthcare institutions but also strengthens sustainable environmental governance in the healthcare sector.

In general, previous studies have been limited in comprehensively reviewing how financial aspects can function as a mediating variable linking the three main levels in the medical waste management system, namely the micro level (individual awareness), meso level (hospital operational capacity), and macro level (government support and regulations). Most previous studies have focused more on technical aspects or regulatory compliance without highlighting the importance of funding constraints as a factor that can hinder policy effectiveness and internal capacity building. In fact, funding is a crucial component in providing the infrastructure, facilities, and training necessary to support a medical waste management system in accordance with standards (Amos et al., 2020). Therefore, this study seeks to fill this gap by developing a conceptual model for improving hospital waste management performance based on a multi-level approach (micro, meso, macro), in which the financial aspect is positioned as an essential and strategic mediating variable.

This paper also aims to complement previous studies that have not fully integrated a multi-level approach in analyzing hospital waste management performance. Previous studies tend to be sectoral in nature and have not considered the interrelationship between individual awareness, institutional capacity, and policy support. In addition, very few studies have placed the financial aspect as a mediating variable that bridges these three levels. Thus, this study offers a more comprehensive and systemic perspective to improve the effectiveness of sustainable hospital waste management.

In accordance with these objectives, seven main research questions were posed to develop a model for improving hospital waste management performance. First, what is the role of Individual Social Responsibility (ISR) at the micro level in encouraging compliance with management performance at Arosuka Regional General Hospital? Second, to what extent do learning and growth at the meso level affect hospital performance? Third, how does auditing affect hospital waste management performance? Fourth, to what extent do financial aspects influence hospital management performance? Fifth, how do financial aspects act as a mediator between ISR and hospital management performance? Sixth, how do finances mediate the relationship between learning and growth and hospital performance? Seventh, how do financial aspects become a mediating variable between audits and hospital waste management performance? These seven questions form the conceptual basis for developing a research framework to address the multidimensional challenges of hospital medical waste management..

This study is based on the view that effective hospital waste management requires synergy between three levels of intervention: micro, meso, and macro—with financial factors considered as a strategic connecting element. At the micro level, individual awareness through Individual Social Responsibility (ISR) forms the basis for disciplined behavior and compliance with medical waste management procedures. At the meso level, organizational learning and growth play an important role in improving technical capabilities, operational efficiency, and the application of environmentally friendly technologies. Meanwhile, at the macro level, strong regulations and consistent implementation of environmental audits are the foundation for accountable and sustainable waste management. However, all these elements cannot function effectively without adequate financial support. Therefore, the financial variable serves as a strategic mediator that bridges individual awareness, institutional capacity, and government policy support in improving medical waste management performance at Arosuka Regional General Hospital, Solok Regency.

THEORITICAL FRAMEWORK

Individual Social Responsibility

Individual Social Responsibility (ISR) at the micro level is a theory that explains the role of individual awareness, values, and responsibility towards the environment within the scope of organizational activities, including in hospital waste management (Amos et al., 2020). In the context of hospital waste management performance, ISR emphasizes that every individual, whether medical personnel, non-medical personnel, or other related parties, has a moral and practical contribution in ensuring that waste management practices are carried out safely, responsibly, and in accordance with standards (Alharbi et al., 2021). This theory is based on the principle that systemic changes in waste management do not only depend on institutional structures and policies, but also on individual behavior that is consistent with the values of sustainability and environmental health (Alighardashi et al., 2024). ISR encourages the creation of a more environmentally conscious organizational culture, where simple actions such as sorting waste properly, not mixing medical waste with domestic waste, and following waste handling procedures become part of the personal commitment of every actor in the hospital system[22]. Within the ISR theoretical framework, individual behavior not only reflects compliance with regulations, but also demonstrates ethical and social dimensions that strengthen the overall performance of hospital waste management.

Lai 2020 explains that aspects of individual social responsibility can be measured through several indicators that are closely related to generally expected social values. These indicators include individual responsibility in carrying out roles, fulfillment of established obligations, openness to receiving advice and feedback, and attention to morality in every action. These four indicators reflect dimensions of value that are not only important in social interactions, but also form the basis for creating an ethical work culture oriented towards the common good. Thus, individual social responsibility is not only understood as a normative obligation, but as a reflection of values that directly contribute to improving organizational performance, including in the context of hospital waste management..

Individual Social Responsibility (ISR) at the micro level plays an important role in supporting the success of hospital waste management through personal awareness, values, and commitment to the environment. A study by Thakur and Sharma (2021) in India shows that a lack of awareness and training are major obstacles to medical waste management practices. Grose et al. (2012) in the UK emphasized the importance of changing values and behaviors among healthcare workers (Grose et al., 2012). In Germany, Jungbluth (2023) found that active individual participation is essential even though understanding of the benefits of recycling is already high (Jungbluth et al., 2024). Keyvanara and Sajadi in 2021 in Iran added that individual contributions can align hospital operations with social and environmental responsibilities. These findings indicate that ISR has a significant impact on building effective and sustainable hospital waste management performance. ISR contributes significantly to improving hospital waste management performance..

Learning and Growth

The theory of learning and growth at the meso level is an important foundation for understanding and evaluating hospital waste management performance because it is directly related to the internal capacity of organizations to create sustainable change (Nafari & Rezaei, 2022). At this level, learning and growth refer to the ability of hospital institutions to develop human resource competencies, strengthen organizational knowledge systems, and utilize technology and innovation in medical waste management (Alboliteeh et al., 2023). According to Zhihan et al. (2023) in the Balanced Scorecard framework, the learning and growth dimension is a major driver of operational efficiency and sustainable innovation. In the context of hospitals, this includes regular training, raising environmental awareness, and using environmentally friendly technologies. Research by Lyman et al. (2019) proves that hospitals that implement a continuous learning system experience an increase in compliance with waste management standards of up to 90%. Thus, the learning and growth aspects play a strategic role in creating an adaptive, innovative, and environmentally sustainable organization.

Within the scope of hospital waste management, learning and growth theory can be used to assess the extent to which medical and non-medical personnel are able to improve their competence, awareness, and behavior in sustainable waste management (Turner & Maldonado, 2025). This theory emphasizes the importance of human resource development as a strategic asset of the organization through training, organizational learning, and managerial innovation. According to Gabutti et al. (2023), learning and growth are pillars that strengthen the internal dimensions of an organization by encouraging the creation of a work culture that is adaptive to environmental changes. In the context of hospitals, this theory helps evaluate how medical and non-medical personnel understand and implement waste management procedures, such as sorting waste according to category, using personal protective equipment, and complying with operational standards. Research by Amos et al. (2020) shows that increasing human resource capacity through continuous learning can reduce the risk of medical waste contamination by up to 40%, making this theory an important foundation for creating effective and sustainable waste management.

Broccardo (2015) explains that indicators in the learning and growth aspect are closely related to how organizations can create value in the future by improving their internal capabilities. Furthermore, according to

Amos et al. (2021), learning and growth variables have a significant influence on hospital facility management performance. This is because in the face of a healthcare revolution, such as an epidemic crisis, the introduction of new services, or organizational restructuring, hospitals are required to continue to adapt through learning processes, competency development, and continuous innovation. In line with this, Dri et al. (2018) emphasize that learning and growth, especially in the form of training and innovation, are important elements in improving hospital waste management performance. Staff training plays a crucial role in minimizing health risks and waste contamination. Meanwhile, Reinhardt & Gordon (2018) add that formal training programs for employees are key to the successful implementation of waste management systems. Without adequate understanding of the procedures and systems in place, waste management will not be effective.

Amos et al. (2020) in their research outlined that the learning and growth aspect includes several important indicators, namely staff development and training programs, employee turnover rates, and employee competencies. Staff training and development programs are closely related to improving waste management capabilities, particularly to prevent and control infections in hospital environments. Meanwhile, the employee turnover indicator highlights the frequency of employee rotation or transfer within hospital institutions. The employee competency aspect focuses on workforce capabilities, particularly in the sorting and handling of hospital waste in accordance with applicable health and safety standards..

Audit

Audits at the macro level in the context of hospital waste management performance can be explained through legitimacy theory and institutional theory (Modell, 2019). Legitimacy theory explains that hospitals as public institutions need to maintain public trust through transparent, accountable waste management practices that comply with environmental regulations (Alharbi et al., 2021). According to Choi & Woo (2022), audits at the macro level serve to ensure that the waste management policies and systems implemented by hospitals are in line with national standards and globally recognized sustainability principles. Meanwhile, institutional theory emphasizes that audits serve as a formal mechanism to enforce compliance with norms, values, and institutional rules that govern environmental governance in the health sector. Thus, audits are not only a monitoring tool but also an instrument for organizational learning in improving the accountability and efficiency of hospital waste management.

In this context, audits serve as instruments for monitoring, evaluating, and ensuring the quality of all hospital waste management processes in accordance with sustainability principles and applicable regulations (Thakur, 2021). Audits not only assess administrative compliance with environmental and health standards, but also review the effectiveness of policies, the efficiency of resource use, and the consistency of waste management procedures at the operational level. Through audits, hospitals can identify areas for improvement, assess environmental risks, and increase transparency in environmental performance reporting to stakeholders (Thakur, 2021). The audit results also play a role in strengthening hospital governance, encouraging the implementation of an Environmental Management System, and building public trust in the hospital's commitment to protecting patients, medical staff, and the community from the negative impacts of medical waste (Hsu et al., 2021)..

In the context of hospital waste management performance, audit indicators can be assessed through two main approaches, namely internal audits and external audits. Internal audits are conducted by the hospital's supervisory unit to ensure that all waste management processes are carried out in accordance with standard operating procedures (SOPs), environmental regulations, and applicable quality management policies. These audits serve as an internal control mechanism to detect potential non-compliance, assess the effectiveness of waste management programs, and provide recommendations for continuous improvement (Ceretta et al., 2023). Meanwhile, external audits are conducted by independent institutions or government agencies such as the Ministry of Health and the Ministry of Environment and Forestry to assess the hospital's level of compliance with national regulations and international standards related to medical waste management. External audits provide objective validation of hospital performance and strengthen accountability and transparency in sustainable hospital environmental management..

Finance

Finance explains that financial factors play a central role as a bridge between variables such as individual responsibility (Individual Social Responsibility), service quality, and government regulations in achieving effective and sustainable waste management performance. Individual awareness, service standards, and government policies have great potential in driving improvements in waste management; however, their implementation is highly influenced by the availability and allocation of financial resources. Without adequate financial support, training programs for staff, the procurement of waste management infrastructure, and compliance with regulations cannot function optimally. For example, a medical worker who is aware of the importance of waste management will not

be able to perform procedures correctly if the hospital does not provide facilities such as standardized medical waste bins.

Several previous studies emphasize that financial factors play a significant mediating role in improving hospital waste management performance. A study by Shortell et al., (2021) showed that without sufficient financial support, individual efforts to improve medical waste management performance often fail to be optimal, despite high awareness. Another study by Eilola et al., (2021) identified that the quality of service in waste management heavily depends on financial capacity to provide facilities, training, and environmentally friendly technologies. Meanwhile, research by Shortel in 2021 revealed that strong government regulations would not be effective if not complemented by financial support and incentives that enable hospitals to comply with environmental standards. Thus, the previous literature supports the view that financial factors are not only technical enablers but also serve as a vital bridge in ensuring the connection between individual awareness, service quality, and regulatory policies in realizing effective hospital waste management performance.

Financial indicators play an important role in supporting hospital waste management performance. Three key indicators that can be relied upon in this context are the allocation of the budget approved by management, the timeliness of fund disbursement, and cost-effectiveness. Budget allocation reflects managerial commitment to providing adequate resources for all stages of waste management, as stated by Kumari et al. in 2013 and Amos et al. in 2020. The timeliness of fund disbursement becomes crucial to prevent operational delays, such as in the procurement of facilities or payment to third-party services. Meanwhile, cost-effectiveness assesses the efficiency of fund usage to achieve optimal results in safe and environmentally friendly waste management[. Therefore, these indicators become strategic components in ensuring the sustainability of the hospital waste management system.

RESEACH & METHODS

This study was conducted by Arosuka Hospital. This type of research can be categorized as causal quantitative research. The purpose of this study is to examine the effect of one variable on another (Sugiono, 2016). The results of this study are expected to form a theoretical basis that can provide understanding, predictive capabilities, and tools to control the observed phenomena. The focus of this study is on the entire population of 359 employees working at Arosuka Regional General Hospital. This population includes medical, non-medical, and administrative staff who are directly or indirectly involved in the hospital waste management process. This population was selected based on the consideration that all elements of human resources in the hospital have their respective contributions and responsibilities in supporting effective waste management performance. To ensure data representativeness, this study used purposive sampling with the sample size calculated using the Slovin formula. With a population of 359 employees at Arosuka Regional General Hospital and a margin of error of 5% (e = 0.05), the sample size was 190 respondents. Respondents were selected purposively, namely employees who were directly involved in the hospital waste management process..

Data collection in this study was conducted using a structured questionnaire designed to measure five main variables, namely Individual Social Responsibility, growth and learning, audit, finance, and hospital waste management performance. The analysis technique used was Structural Equation Modeling (SEM) with the help of PLS 3 software. SEM analysis was carried out in two main stages: outer model and inner model.

In the outer model testing, an evaluation was conducted on the loading factor, convergent validity, discriminant validity, and construct reliability to ensure that each indicator consistently represented the latent variables being measured (Hair, & McDaniel, 2022). Furthermore, inner model testing was used to test the feasibility of the structural model, which was assessed through predictive relevance (Q^2), Goodness of Fit Index (GFI), and R-Square (R^2) values [37]. In addition, path analysis was conducted to determine the direction and strength of the influence between variables, both directly and indirectly. Hypothesis testing was performed using the t-test, with rejection criteria if the t-value > t-table or p-value < α, with a significance level (α) set at 0.05. This approach aims to provide a strong empirical understanding of the relationships between variables in an effort to improve the performance of hospital waste management in a sustainable manner (Hair, & McDanile.,2022)

RESULT & DISCUSION

Result

Outer Model

Before testing the hypotheses, an assessment of the reflective measurement model was conducted to validate the manifest variables (indicators) and constructs that would be further analyzed. This preliminary evaluation included examining the factor loading values, which indicate the strength of the relationship between each manifest

variable and its corresponding latent construct. According to Hair and McDaniel (2022), reflective indicators should be removed from the measurement model if their loading value (λ) is below 0.6, after which the model needs to be recalibrated. Conversely, if the loading value (λ) exceeds 0.6, the indicator is considered valid. Indicators with high loading values make a significant contribution to explaining the latent variable they represent, while those with low loading values provide minimal explanatory power. The factor loading (λ) values for each indicator are presented in Table 1 below.

Table 1. Factor Loadings of Variable.

Item	Individual Social Resposibility (X1)	Pembelajaran Dan Pertumbuhan (X2)	Audit (X3)	Finance (M)	Kinerja Limbah Rumah Sakit (Y)
1	0.933	0.929	0.743	0.887	0.936
2	0.911	0.948	0.848	0.892	0.920
3	0.919	0.945	0.898	0.887	0.934
4	0.903	0.943	0.913	0.875	0.918
5	0.939	0.932	0.913	0.901	0.928
6	0.931		0.878	0.918	0.890
7			0.825	0.914	0.904

Based on the results of the analysis using Smart-PLS 3.0, all manifest variables in individual social responsibility, learning and growth, auditing, finance, and hospital waste management performance have a loading factor value above 0.60, ranging from 0.737 to 0.913. This indicates that all indicators are valid in measuring the relevant latent variables and contribute significantly to explaining them. Convergent validity is an important aspect in construct measurement, which is used to assess the extent to which a construct can explain the variance of the indicators that form it, according to Hair et al (Hair et al., 2019). One of the main measures of convergent validity is the Average Variance Extracted (AVE), with a minimum threshold of 0.50. If the AVE value exceeds 0.50, the construct is considered to have good convergent validity. The results of the discriminant validity analysis are shown in Table 2, which compares the AVE values of each latent variable.

Table 2. Convergent Validity Test Results.

Variabel	Rata-rata varians diekstraksi (AVE)
Individual Social Resposibility (X1)	0.601
Learning and Growth (X2)	0.554
Audit (X3)	0.507
Finance (M)	0.532
Hospital Waste Performance (Y)	0.742

Based on Table 2, it can be concluded that the five latent variables have Average Variance Extracted (AVE) values that exceed the minimum limit of 0.5. This indicates that the indicators for the individual variables of social responsibility, learning and growth, audit, finance, and hospital waste management performance have good convergent validity. To measure discriminant validity, there are three commonly used analysis methods, namely the Fornell and Larcker Criterion, Cross Loadings, and Heterotrait-Monotrait Ratio (HTMT). Among these three methods, HTMT analysis is considered the most superior. In this study, all HTMT ratio values were below 0.85, as recommended by Henseler et al. (2015). Therefore, discriminant validity in this study was assessed using the HTMT approach, and the results of the analysis are presented in Table 3.

Table 3. Discriminant Validity Test Results.

Finance (X4)	Individual social responsibility (X1)	Hospital Waste Performance (Y)	Learning And Growth (X2)	Audit (X3)
0.713				
0.840	0.835			
0.750	0.636	0.840		
0.750	0.721	0.830	0.847	
0.404	0.658	0.522	0.488	
0.377	0.731	0.623	0.635	0.350
0.344	0.665	0.686	0.769	0.234

The results of the discriminant validity test in Table 3 show that all HTMT ratio values between the constructs of Finance (X4), Individual Social Responsibility (X1), Hospital Waste Performance (Y), Learning and Growth (X2), and Audit (X3) are recorded below the 0.85 limit. These results confirm that each construct has clear differences and that there is no conceptual multicollinearity. Thus, this research model meets the criteria for adequate discriminant validity, so that each variable can be interpreted separately and supports the reliability of the structural relationships between constructs in the model. In general, these results provide evidence that all latent variables in this study have met strict and reliable discriminant validity criteria. Thus, it can be concluded that the constructs in this model stand independently and do not overlap theoretically or empirically. In addition, composite reliability analysis also confirms strong internal consistency, as indicated by Cronbach's Alpha and Composite Reliability values that all exceed the recommended minimum threshold of 0.70. Details of the analysis results can be seen in Table 4.

Table 4. Composite Reliability Test.

Variabel	Cronbach's alpha	Keandalan komposit (rho_c)
Individual Social Resposibility (X1)	0.965	0.972
Learning and Growth (X2)	0.957	0.969
Audit (X3)	0.929	0.966
Finance (M)	0.959	0.966
Hospital Waste Performance (Y)	0.959	0.968

The reliability test results presented in Table 4 indicate that all variables in this study demonstrate a high level of reliability. This is evidenced by the Cronbach's Alpha and Composite Reliability values, all of which exceed the acceptable threshold of 0.6, signifying good internal consistency among the items within each construct. The Individual Social Responsibility (X1) variable recorded a Cronbach's Alpha of 0.965 and a rho_c of 0.972, indicating excellent stability of the measurement items. Similarly, the Learning and Growth (X2) variable showed high reliability with values of 0.957 and 0.969, suggesting consistent responses from participants. The Audit (X3) variable achieved values of 0.929 and 0.966, reflecting strong reliability in assessing hospital audit aspects. Furthermore, the Finance (M) variable obtained values of 0.959 and 0.966, while the Hospital Waste Management Performance (Y) variable recorded 0.959 and 0.968. These findings confirm that all instruments used in this study meet statistical reliability requirements. Therefore, the items within each construct consistently represent the intended concepts, ensuring that the collected data are reliable for subsequent structural model testing and inter-variable relationship analysis..

Inner Model

Inner model testing aims to assess the suitability of structural models with data through latent variable analysis. This process begins with evaluating the measurement model first, before proceeding to test the structural model using the bootstrapping method. The evaluation is based on the t-statistic value (≥ 1.96) and p-value (≤ 0.05) to determine whether the hypothesis is accepted or rejected. In addition, the coefficient of determination (R^2) is used to measure the contribution of exogenous variables to endogenous variables. According to Chin & Newsted (1998), the strength of the R^2 value is categorized as strong (0.67), moderate (0.33), and weak (0.19). In the context of this study, the R^2 value for the hospital waste management performance variable can be seen in Table 5, which shows the extent to which these variables are influenced by other factors in the model.

Tabel 5. Coefficient of Determination (R-Square).

Endogenous Variables	R-square
Kinerja Limbah Rumah Sakit (Y)	0.878

Based on Table 5, it states that hospital waste management performance has an R Square value of 0.878, which means that 87.8% of the variability in environmental performance at the Arosuka regional public hospital can be explained by independent variables, namely individual social responsibility capital (X1) and service quality (X2). Government Regulations (X3), Finance (X4), Meanwhile, the remaining 12.2% is influenced by other factors outside this research model. Path analysis was used to measure how strong the influence of a variable is on another variable, either directly or indirectly, using the bootstrapping method to assess the significance of this influence. In this study, hypothesis testing was conducted at a significance level of 5%, with a critical value of 1.96. This means that the relationship between variables in the research model is considered statistically significant if it meets these criteria. The complete analysis results are shown in Table 6.

Table 6. Variable Relationship Constructs.

Costruct	Coefisient	T Statistik (| O/STDEV |)	P Values
Individual Social Responsibility (X1) → Hospital Waste Management Performance (Y)	0.291	4.567	0.000
Learning and Growth (X2) → Hospital Waste Management Performance (Y)	0.164	3.338	0.001
Audit (X3) → Hospital Waste Management Performance (Y)	0.149	5.860	0.000
Finance (X4) → Hospital Waste Management Performance (Y)	0.071	2.182	0.030
Individual Social Responsibility (X1) → Finance (M) → Hospital Waste Management Performance (Y)	0.050	2.149	0.032
Learning and Growth (X2) → Finance (M) → Hospital Waste Management Performance (Y)	0.047	2.517	0.012
Audit (X3) → Finance (M) → Hospital Waste Management Performance (Y)	0.034	2.125	0.033

Based on the path analysis results presented in Table 6, it can be observed that all relationships among variables in the research model demonstrate statistically significant effects at the 5% significance level ($p < 0.05$). The coefficient values indicate both the direction and strength of each variable's influence on hospital waste management performance. The variable Individual Social Responsibility (X1) has a significant direct effect on hospital waste management performance (Y), with a coefficient of 0.291 and a significance value of 0.000, showing that increased individual awareness contributes meaningfully to improving waste management practices. Furthermore, Learning and Growth (X2) also has a positive and significant influence, with a coefficient of 0.164 and a significance value of 0.001, indicating that enhanced human resource capacity through training and innovation strengthens waste management effectiveness. Meanwhile, the Audit (X3) variable shows a significant positive effect with a coefficient of 0.149 and a significance value of 0.000, emphasizing the crucial role of audits in ensuring compliance with waste management standards. Additionally, Finance (X4) has a coefficient of 0.071 with a significance value of 0.030, suggesting that financial support significantly contributes to strengthening the implementation of hospital waste management systems.

Moreover, the results of the indirect effect analysis reveal that finance acts as a significant mediating variable in three key relationships: (1) between Individual Social Responsibility and waste management performance (coefficient = 0.050; p = 0.032), (2) between Learning and Growth and performance (coefficient = 0.047; p = 0.012), and (3) between Audit and performance (coefficient = 0.034; p = 0.033). These findings confirm that financial support enhances the influence of micro, meso, and macro-level factors on overall hospital waste management performance. This result reinforces that strengthening the financial aspect at RSUD Arosuka is essential to optimizing the impact of social responsibility, learning and growth, and audit functions on hospital waste management performance as a whole through financial mediation.

DISCUSION

Research analyzing the Role of Finance Mediation in Improving Hospital Waste Management Performance through a Multi-Level Approach at Arosuka Regional General Hospital shows a significant relationship between variables at the micro, meso, and macro levels and hospital waste management performance, with finance as an important mediating variable. These findings indicate that individual social responsibility at the micro level, learning and growth at the meso level, and auditing at the macro level have a direct positive effect on hospital waste management performance.

At the micro level, individual social responsibility (ISR) at the Arosuka Regional General Hospital (RSUD) is an important foundation in supporting the success of hospital waste management performance. According to the theory of individual social responsibility proposed by Grose et al. (2012) and reinforced by Yora Cho (2020), ISR refers to the awareness and personal commitment of every individual, whether medical, non-medical, management, or visitors, to play an active role in protecting the environment and public safety through concrete daily actions. At Arosuka Regional General Hospital, this social responsibility is reflected in the behavior of individuals in sorting medical and non-medical waste, using personal protective equipment when handling waste, and complying with waste management procedures in accordance with applicable operational standards. Lulaj (2023) states that every individual in the hospital environment plays a crucial role in the waste management chain. Anastasio Etall 2025 states that strong ISR encourages the formation of an environmentally conscious work culture, where responsibility is not only imposed on systems or regulations but is also embedded in the daily behavior of staff and management.

At the meso level, learning and growth play an important role in improving hospital waste management performance because this aspect is directly related to the ability of human resources to manage waste effectively, safely, and sustainably. Through training programs, competency development, and capacity building for innovation, medical and non-medical personnel can understand and apply waste management procedures in accordance with operational standards. According to Yeboah & Zogli, (2025) organizational learning serves as the foundation for creating long-term value through skill strengthening and adaptation to change. Meanwhile, Amos et al. (2021) emphasize that improving staff capabilities through training and continuous learning is essential to cope with the ever-evolving dynamics of healthcare services. Similar opinions are expressed by Changede et al. (2022) and Amos et al. (2020), who emphasize the importance of formal training for workers in preventing contamination risks and ensuring the effectiveness of waste management systems. Learning and growth at the meso level not only strengthen individual performance but also create an organizational culture that cares about the environment and is oriented towards improving hospital waste management performance..

Meanwhile, at the macro level, auditing plays a strategic role as a monitoring and evaluation mechanism that ensures that all hospital waste management processes are carried out in accordance with standards, regulations, and sustainability principles. In the context of this study, auditing covers two important dimensions, namely internal auditing and external auditing. Internal auditing focuses on the evaluation process carried out by the hospital to monitor the effectiveness of the waste management system, including compliance with operational procedures, efficiency of resource use, and accuracy of reporting. Meanwhile, external audits involve independent institutions or government agencies that objectively assess the hospital's environmental performance to ensure transparency and accountability. The results of the study show that consistent implementation of audits can strengthen internal control, improve regulatory compliance, and encourage continuous improvement. These findings are in line with the views of Johnstone (2022) and Banister et al. (2022), who emphasize that audits serve as a strategic tool in fostering good environmental governance, reducing potential violations, and enhancing the reputation of health institutions as socially and ecologically responsible organizations...

However, this influence becomes stronger when mediated by adequate financial resources and management. At the micro level, a high level of individual social responsibility encourages improved waste management performance at the Arosuka Regional General Hospital in West Sumatra. However, the implementation of these measures, such as the procurement of personal protective equipment, waste sorting facilities, and technical training, is highly dependent on the availability of sufficient budget allocations. The active participation of health workers in waste separation, the use of personal protective equipment (PPE), and compliance with technical training are key factors in creating effective hospital waste management performance. Studies by Jungbluth et al. (2024) in the NHS and Drio 2022 confirm that socially responsible individual behavior can improve medical waste separation and recycling practices, thereby positively impacting public health and the environment[41]. However, the successful implementation of these measures is highly dependent on the availability of adequate budget allocations. As revealed in the studies by Asma 2023[42] and Alharbi et al. (2021), limited funds and a lack of training are the main obstacles to providing effective medical devices that create standard-compliant management performance..

Similarly, at the meso level, effective learning and growth in the context of hospital waste management is highly dependent on adequate financial support so that the performance improvement process can run optimally and sustainably. The results of the study show that the availability of funds plays an important role in supporting various human resource development programs, such as technical training on sorting, storing, and processing medical waste in accordance with environmental standards. Financial support enables hospitals to provide modern, environmentally friendly facilities and infrastructure, such as safe waste storage, low-emission incinerator systems, and digital waste monitoring technology. In addition, adequate funding also supports the implementation of a reward and punishment system for health workers who play an active role in waste management, thereby fostering a more disciplined and responsible organizational culture. This study reinforces the views of Amos et al. (2021) and Dri et al. (2018), who assert that investment in learning and growth through sustainable financial support can improve operational efficiency, strengthen compliance with environmental regulations, and create a waste management system that is more adaptive to changes and health crises. (Amos et al., 2020).

At the macro level, the success of implementing environmental audits in improving waste management performance at Arosuka Regional General Hospital proved to be more optimal when mediated by adequate financial resources. Financial support enabled the hospital to follow up on audit findings effectively through system improvements, provision of waste treatment facilities in accordance with standards, and regular internal and external audits. Budget availability also plays a role in increasing transparency and accountability through the financing of monitoring, reporting, and environmental certification activities. The results of the study show that without sufficient financial support, audit recommendations often cannot be fully implemented due to resource constraints. With adequate funding, hospitals can ensure that each audit recommendation is translated into concrete actions that improve waste management efficiency and compliance with environmental regulations. These

findings reinforce the view of Putri and Suryani (2023) that the integration of environmental audits and strong financial support will create more transparent, efficient, and sustainable waste management in the healthcare sector.

The successful implementation of audits in improving waste management performance at regional public hospitals (RSUD) has been shown to increase significantly when mediated by adequate financial availability. Financial resources play a vital role in ensuring that audit findings can be concretely implemented through the provision of standardized waste treatment facilities, enhancement of human resource capacity, and the application of continuous monitoring and evaluation systems. The availability of sufficient funds enables hospitals to follow up on audit findings with technical improvements, investments in environmentally friendly technologies, and training programs for both medical and non-medical staff in handling hazardous waste. Without sufficient financial support, audits would remain merely administrative procedures without producing tangible changes in practice. Therefore, the synergy between audit outcomes and appropriate budget allocation is key to achieving effective, efficient, and sustainable waste governance. As emphasized by the Ministry of Environment and Forestry (KLHK, 2024), the sustainability of waste management largely depends on the consistency of audits supported by institutional funding.

The existence of audits enables RSUD Arosuka in West Sumatra to enhance the effectiveness of its waste management system through the provision of standard-compliant facilities, staff training, and adherence to environmental regulations. Audits function as an evaluation mechanism that helps the hospital identify weaknesses in waste management processes and provide measurable recommendations for improvement. Through structured audit results, hospital management can allocate resources more effectively to strengthen waste treatment infrastructure, update operational procedures, and ensure that both medical and non-medical staff fully understand environmental safety standards. Moreover, consistent audit implementation promotes transparency and accountability in the hospital's environmental governance. Thus, audits serve not only as a monitoring tool but also as a strategic instrument for fostering sustainable improvements in waste management performance at RSUD Arosuka...

CONCLUSION

This study found that the positive influence of individual social responsibility, learning and growth, and audits on improving waste management performance at Arosuka Regional General Hospital would not be optimal without the mediation of adequate financial factors. Although in theory and practice these three factors play an important direct role, this study shows that when not supported by sufficient budget allocation, various policies, individual commitments, and compliance with environmental regulations have the potential to fail to be implemented optimally. This is surprising because it confirms that financial availability is not only a supporting element but also a key link that determines the effectiveness of hospital waste management performance in accordance with established standards. In fact, Arosuka Regional General Hospital, which was previously considered quite disciplined in regulatory compliance, was only able to demonstrate significant waste management performance after implementing strategic budget management to support the procurement of equipment, human resource training, and a sustainable waste treatment system. This finding changes the perspective that regulations and awareness alone are not enough without financial resources; without them, everything will only remain at the administrative level without tangible results in the field..

In the discipline of economics, studies on development in hospital waste management emphasize the importance of efficiency, sustainability, and proper resource management. Conceptually, this study expands the understanding of the relationship between multi-level approaches (micro, meso, and macro) and financial mediation variables in improving hospital waste management performance. This approach shows that factors such as individual social responsibility, learning and growth, and auditing cannot be effective without adequate financial support. The availability of financial resources is a key driver that enables the optimal implementation of environmental policies, ranging from increasing human resource capacity to providing waste management infrastructure that meets standards. In this context, this study enriches the literature on the importance of financial support as an enabler in translating social values, organizational learning, and oversight mechanisms into sustainable waste management performance in the health sector. Methodologically, this study demonstrates the importance of using a mediation model in a multi-level approach that can serve as a reference for similar studies in other public service fields. This model can be applied to test the effectiveness of cross-level and cross-sector management policies or strategies in a more comprehensive and systematic manner..

This study does not describe the depth of social and cultural dynamics within organizations that can influence individual behavior, financial efficiency, and the implementation of regulations in a more contextual manner. Further research could also integrate qualitative approaches, such as ethnographic studies or in-depth interviews, to uncover organizational cultural values, individual motivations, and implementation barriers in the field that are not detected through quantitative data. In addition, the development of structural models that incorporate other

variables such as the digitization of waste management systems, environmentally friendly technologies, or public participation can also enrich understanding and provide more complex and applicable theoretical contributions in the context of sustainable hospital waste management.

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