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Analysis of Human Resource Behavior in Solid Medical Waste Management: Case Study From Regional Public Hospitals Drs. H. Amri Tambunan Deli Serdang, Indonesia

Cristo Mori Romario Manurung[1*], Delvian[2], Sri Malem Indirawati[3]

[1,2,3] Universitas Sumatera Utara, Medan, Sumatera Utara.
Email: cristo1806@gmail.com[1*], delvianibrahim@yahoo.co.id[2], srimalem@usu.ac.id[3]

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ABSTRACT
This research collects and analyzes quantitative data on two research variables: the management of solid medical waste and the behavior (knowledge, attitudes, and actions) of human resources (HR), specifically nurses, environmental health officers, and cleaning service officers. The research population comprised 274 individuals, including nurses, environmental health officers, and cleaning service officers. The sampling technique was purposive, with the inclusion criteria being a work period of more than 2 years. Data was collected through interviews, observations, and document reviews at Drs. H. Amri Tambunan Hospital, Deli Serdang Regency. The data collected was analyzed using frequency distribution with the SPSS 20 application. The results showed that the knowledge of nurses, environmental health officers, and cleaning service officers regarding solid medical waste management was categorized as good (61.1%). The attitudes of these personnel were all in the good category (100%). In comparison, their actions in managing solid medical waste were categorized as good (85%)—the management of solid medical waste at Drs. H. Amri Tambunan Regional General Hospital, Deli Serdang, involves several stages. The reduction and sorting processes still rely on chemical products for cleaning, and the storage at the Temporary Storage Facility (TPS LB3) does not include refrigeration facilities for cases where solid medical waste is stored for more than 2 days after production. Additionally, during transportation, officers are sometimes observed not wearing complete personal protective equipment (PPE) such as helmets, face masks, eye protection, aprons, foot protectors, and gloves. Furthermore, the use of chemical disinfection for waste processing has not received approval from the Environmental Service.

Keywords: Human Resource Behavior, Solid Medical Waste Management, Regional Public Hospitals.

I. Introduction

The background of this research stems from the suboptimal management of solid medical waste in Indonesia. Solid medical waste generated from 2,820 hospitals and 9,884 health centers in the country amounts to 290 tons per day, excluding waste from clinics, transfusion units, and pharmacies. The available facilities for managing solid medical waste are still limited, and their capacity is insufficient. There are only 10 licensed medical waste management services in Indonesia, with a total waste management capacity of 170

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tons daily. Additionally, only 87 hospitals have incinerators to process their medical waste, with a combined capacity of 60 tons daily. In Deli Serdang Regency, hospitals generate an average of ± 250 to 300 kg of solid medical waste daily or approximately ± 5,250 kg per week. This figure only accounts for hospitals, excluding other health service facilities such as community health centers and clinics. The B3 waste balance is included in the attachment.

Data from P2M-PL (Eradication of Infectious Diseases and Environmental Health) indicates that curative syringe waste in Indonesia is estimated to be around 300 million units annually. Waste from special syringes used for immunization is estimated at approximately 66 million units annually. Of these, 36.8 million units are from syringes used for baby immunizations, around 10 million are for pregnant women or women of childbearing age, and about 20 million are for schoolchildren. As a result, Indonesia's amount of solid medical waste, particularly sharp objects, has become very high—a preliminary study conducted at Drs. H. Amri Tambunan Regional General Hospital in Deli Serdang in October 2023, through direct observation and interviews with a B3 waste officer and a team member of the environmental health department, revealed that solid medical waste generated from various health service units in the hospital, such as treatment rooms, inpatient rooms, laboratory rooms, and other service areas, has not been managed effectively. Behavior is a response to external stimuli, where the environment encourages individuals to act based on the influences of their surroundings. Individuals who know how to manage their waste will likely adopt proper behaviors (Ibrahim et al., 2018). Other research conducted in a hospital in Jember City found that medical waste management was significantly influenced by the education, knowledge, and supervision of waste management officers' behavior (Yanik et al., 2019).

II. Research Method

The research collected and analyzed quantitative data on two main variables: the management of solid medical waste and the behavior (knowledge, attitudes, and actions) of human resources (HR), specifically nurses, environmental health officers, and cleaning service officers. The research was conducted at Drs. H. Amri Tambunan Regional General Hospital in Deli Serdang Regency. The study was conducted starting in October 2023, encompassing activities such as the initial survey, proposal preparation, consultations, data collection, and the compilation of the research report. The research population comprised 274 individuals, including nurses, environmental health officers, and cleaning service officers.

2.1. Sample

The sample is a data source that represents the population, ensuring that the characteristics of the population are reflected in the sample (Sugiyono, 2021). The Slovin formula used is:

$$n = \frac{N}{1 + Ne^2}$$

Info
n Number of Samples
N= Amount of Population
e= Error Tolerance Limit (10%)

Sampling in the selected hospitals was conducted proportionally, based on the population size in each hospital. The following are the details of the research sample.

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Table 1. Details of the Research Sample

Number of Population (people)	Number of Samples (people)
Variables	Table cells, Center
Nurses: 210	Nurses: 70
Distracted officers: 6	Distracted officers: 6
Cleaning service: 58	Cleaning service: 37
Total: 274	113

The sampling technique was purposive, with the following criteria: a work period of more than 2 years, involvement in the solid medical waste management process, the ability to communicate effectively, and availability to participate in the research.

2.2. Research variables

The research variables consist of independent and dependent variables. The independent variables include three factors: behavior (knowledge, attitudes, and actions) of human resources. The dependent variable is the management of solid medical waste.

2.3. Measurement aspect

The independent variable comprises human resources' behavior (knowledge, attitudes, and actions). The researchers developed a questionnaire to assess HR behavior, employing the Guttman scale. This scale in the study provides clear "yes" or "no" answers. The formula used to measure the percentage of responses from the questionnaire, according to Arikunto (2013) in Wijaya (2018), is:

$$\% = \text{Number of correct values} \times 100\% / \text{Number of questions}$$

The result categories in this measurement scale use an ordinal scale with the categories:

a. Good category if the value is > 75-100%
b. Poor category if the value is ≤ 75%

Human resource behavior variables consist of three indicators:

1) Knowledge was measured using a questionnaire containing 19 questions, with two answer choices: yes and no. The knowledge measurement was categorized into two groups: the "poor" category if the respondent answered "yes" to ≤ 75% of the questions, and the "good" category if the respondent answered "yes" to > 76% of the questions.
2) Attitudes were measured using a questionnaire based on a Likert scale, consisting of 17 questions with four answer choices: strongly agree, agree, disagree, and strongly disagree. The attitude measurement was also divided into two categories: the "poor" category if the respondent selected "strongly agree" or "agree" for ≤ 75% of the questions, and the "good" category if the respondent selected "strongly agree" or "agree" for > 76% of the questions.
3) Actions were measured using a questionnaire containing 17 questions, with two answer choices: "doing" and "not doing." The action measurement was categorized into two groups: the "poor" category if the respondent selected "doing" for ≤ 75% of the questions, and the "good" category if the respondent chose "doing" for > 76% of the questions.

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Table 2. Data Measurement Aspects

Variables	Indicator	Measurement Method	Results and Measurement (coding)	Data scale
Independent				
Behavior	• Knowledge	Questionnaire	Respondent answer categories: 1. not good: If the answer to the question is yes ≤ 75% 2. good: If the answer to the question is yes >76% Ordinal	Ordinal
	• Attitude	Questionnaire	Respondent answer categories: 1. not good: If you answer the question strongly agree and agree ≤ 75% 2. good: If you answer the question strongly agree and agree >76%	Ordinal
	• Action	Questionnaire	Respondent answer categories: 1. Not good: If you answer the question, you do ≤ 75% 2. good: If you answer the question >76%	Ordinal
Dependent				
Management of solid medical waste	• Reduce • Save • Collect • Processing • Transporting Questionnaires	Questionnaire	Respondent answer categories: 1. not good: If the answer to the question is yes ≤ 75% sound: If you answer the question yes >76%	Ordinal

2.4. Collecting Data

Primary data was collected through direct observation and interviews using the following methods:

1) Questionnaires were used to collect data on human resource behavior and solid medical waste management.
2) Observation involves collecting data by observing solid medical waste management activities, including reduction and sorting, storage, transportation, processing, disposal, and landfilling

Secondary data for this research was obtained by reviewing existing documents at Drs. H. Amri Tambunan Hospital, Deli Serdang Regency. This included data related to the research variables and supporting data from the personnel department, such as reports and documentation from hospitals in Deli Serdang Regency. Additionally, data was gathered from the North Sumatra Provincial Health Service, Deli Serdang Regency Health Service, North Sumatra Provincial Environmental Service, and Deli Serdang Regency Environmental Service. The data obtained was analyzed using frequency distribution using the SPSS 20 application.

III. Result and Discussion

3.1. Description of Research Location

Drs. H. Amri Tambunan Regional General Hospital in Deli Serdang is a government-owned general hospital in Deli Serdang Regency, serving as a referral center with Class B Education status, as per the Republic of Indonesia Minister of Health Decree Number 1069/Menkes/SK/XI/2008. The hospital has a bed capacity 218

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and facilities and infrastructure for medical services at Drs Regional General Hospital. H. Amri Tambunan: (1) Emergency installation; (2) Outpatient installation.

The outpatient services at the hospital consist of 28 clinics, including gastroenterology and hepatology sub-specialist clinics, gynecological oncology sub-specialist clinics, internal medicine specialist clinics, general surgery, head and neck specialist clinics, obstetrics and gynecology specialist clinics, pediatric specialist clinics, eye specialist clinics, dermatology and genital specialist clinics, ENT (Ear, Nose, and Throat) specialist clinics, pulmonary specialist clinics, neurology specialist clinics, psychiatry specialist clinics, cardiology (heart and blood vessel) clinics, wound care clinics, medical rehabilitation/physiotherapy clinics, child growth and development clinics, geriatrics specialist clinics, orthopedic surgery clinics, neurosurgery clinics, oral surgery clinics, dental and oral health clinics, dental conservation specialist clinics (endodontics), prosthodontics specialist clinics, nutritional consultation clinics, hospital family planning clinic (PKBRS), VCT (voluntary counseling & testing) clinics, KTPA (violence against women and children) clinics, and general practitioner clinics.

1. Inpatient department
2. Intensive care unit (ICU)
3. Central surgical unit (CSU)
4. Medical Support Services, including radiology, integrated laboratory, pharmacy, nutrition, hospital blood transfusion unit (UTD RS), and medical check-ups (MCU)
5. Other supporting services include hemodialysis, internal medicine examinations using endoscopy, stress test, and treadmill service.
6. Additional infrastructure support services, including a 670 KVA generator, laundry, nutrition kitchen, CSSD, ready-to-drink water, children's play area, lactation room, solid waste processing unit (incinerator) with a capacity of 75 kg/hour, wastewater treatment unit (IPAL), cafeteria, mosque, patient lift, ATM center, and central oxygen supply.

3.2. Types and Amounts of Solid Medical Waste

The types and characteristics of solid medical waste at Drs. H. Amri Tambunan Regional General Hospital in Deli Serdang generally aligns with those produced by other hospitals. The types of solid medical waste generated include infectious waste, sharp objects, pathological waste, cytotoxic waste, radioactive waste, pharmaceutical waste, expired chemicals, spillage or leftover packaging, medical equipment containing high levels of heavy metals, and gas cylinders or pressurized containers. Below is a description of the types of medical waste at Drs. H. Amri Tambunan Regional General Hospital in Deli Serdang.

Table 3. Types of Solid Medical Waste at Regional General Hospital Drs. H. Amri Tambunan Deli Serdang in 2023

No Type of Solid Medical Waste	Composition
Infectious waste	• bandages, cotton wool, sanitary napkins, and sticks contaminated with the patient's blood or body fluids • blood tube, plaster, catheter, blood/fluid transfusion bag • mask, gloves/hands, hazmat suit, and hair protector
Sharps waste	Syringe, syringe, syringe, ampoule fragment, bottle/glass/ampoule, lancet, razor, 1x disposable scalpel
Pathological waste	Traces Of Body Tissue, Fetuses, Blood And Vomit
Cytotoxic waste	Used Chemotherapy Bottles
Radioactive waste	Developer And Fixer
Pharmaceutical waste	Expired Medicines
Expired chemical waste, spills, or packaging residue	HCL, formaldehyde

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No Type of Solid Medical Waste	Composition
Medical equipment containing ingredients	Replaced with digital medical equipment
high heavy metals	Handed over to distributors

Table 3 shows that solid medical waste is categorized into nine types: infectious waste, sharp objects, pathological waste, cytotoxic waste, radioactive waste, pharmaceutical waste, expired chemicals, heavy metals, and pressurized gas cylinders. Table 4.2 below presents the average volume of solid medical waste generated from various sources, including inpatient rooms, installations, and polyclinics.

Table 4. The Average Amount of Solid Medical Waste Generated from Hospital Service Units at Regional General Hospital Drs. H. Amri Tambunan Deli Serdang In 2023

No	Month	Average amount of solid medical waste (kg/month)			Average total medical waste produced (kg/month)
		Sharp Objects	Infectious Waste	Pathological Waste	
1	May 2020	209,32	1.554,61	24,36	1.788,29
2	June 2020	257,33	1.179,78	13,28	1.450,39
3	July 2020	302,54	1.691,31	21,89	2.015,74
4	August 2020	408,97	1.632,81	31,17	2.072,95
5	September 2020	435,52	1.646,8	8,52	2.090,84
6	October 2020	627,97	3.267,75	0	3.895,72
7	November 2020	391,63	3.621,32	2,1	4.015,05
8	December 2020	277,44	1.862,75	8,52	2.148,71
9	January 2021	193,4	1.628,99	2,94	1.825,33
10	February 2021	117,15	1.440,75	0	1.557,9
11	March 2021	185	2.763,79	0	2.948,79
12	April 2021	195,41	2.730,33	0	2.925,74
13	May 2021	213,78	2.591,38	0	2.805,16
	Total medical waste for a year	3.815,46	27.612,37	112,78	31.540,61
	Average per month	317,96	2.301,03	9,40	2.628,38 kg/Month
	Average per day	10,45	75,65	0,31	86,41 kg/day

The average amount of infectious waste, sharp objects, and pathological waste produced by each service unit (inpatient rooms, installations, polyclinics, and other units) at Drs. H. Amri Tambunan Regional General Hospital in Deli Serdang is approximately 86.41 kilograms daily, or around 2,628.38 kilograms monthly. This consists of 10.45 kilograms of sharps waste per day, 75.65 kilograms of infectious waste per day, and 0.31 kilograms of pathological waste per day.

3.3. Characteristics of Nurses, Environmental Health Officers and Cleaning Officers

The characteristics of nurses, environmental health officers, and cleaners, including age, gender, education, job type, and length of service, are presented in Table 4.3 below.

Table 5. Characteristics of Nurses, Environmental Health Officers, and Cleaning Officers at Regional General Hospital Drs. H. Amri Tambunan Deli Serdang in 2024

Characteristics	Frequency	Percentage
Age (years)		
18-25	55	48,67
26-35	42	37,16
36-45	12	10,61

Characteristics	Frequency	Percentage
46-55	4	3,56
Gender		
Man	49	43,4
Woman	64	56,6
Education		
D3 nursing	43	38,05
Bachelor's degree in nursing	32	28,32
Senior High School	21	18,58
vocational school	15	13,28
Junior High School	2	1,77
Type of work		
Cleaning service (janitor)	37	32,74
Nurse	70	61,94
Environmental health officer	6	5,32
Years of service (years)		
1-5	24	21,24
6-10	82	72,57
11-15	4	3,54
16-20	3	2,65

Based on Table 5, the characteristics of nurses, environmental health officers, and cleaners by age show that the majority are in the productive age range of 26 to 35 years, totaling 97 people or 86 percent. In terms of gender, there are more females than males, with 64 people, or 56.6 percent, being female. Regarding education, the majority have a Diploma (D3) level of education, totaling 43 people or 38.05 percent. Regarding job type, most work as nurses, with 70 people, or 61.94 percent. Finally, in terms of length of service, the majority have been employed for 1 to 5 years, totaling 24 people or 21.24 percent.

3.4. Human Resources (HR) Behavior in Solid Medical Waste Management

Based on Table 6, the frequency distribution of knowledge among nurses, environmental health officers, and cleaners falls into the good category, with the majority, 69 people or 61.1 percent, demonstrating good knowledge.

Table 6. Frequency Distribution of Human Resource Knowledge Level in Solid Medical Waste Management at Regional General Hospital Drs. H. Amri Tambunan Deli Serdang in 2024

No	Knowledge	Frequency	Percentage (%)
1	Not good	44	39,8
2	Good	69	61,1
	Total	113	100

a. HR Attitude

The frequency distribution of attitudes among nurses, environmental health officers, and cleaners shows that the majority, 113 people or 100 percent, have a positive attitude. This is supported by the tabulation of respondents' answers regarding solid medical waste management in Table 7.

Table 7. Frequency Distribution of HR Attitudes in Solid Medical Waste Management at Regional General Hospital Drs. H. Amri Tambunan Deli Serdang in 2024

No	Attitude	Frequency	Percentage (%)
1	Not good	113	100
2	Good	0	0

No	Attitude	Frequency	Percentage (%)
	Total	113	100

b. HR Actions

The frequency distribution of actions by nurses, environmental health officers, and cleaners falls into the good category, with the majority comprising 85 people or 75.2 percent. Adequate knowledge about solid medical waste is a foundation for appropriate behavior and motivates individuals to act responsibly. This is illustrated in Table 8 and Table 9 below.

Table 8. Frequency Distribution of HR Actions in Solid Medical Waste Management at Regional General Hospital Drs. H. Amri Tambunan Deli Serdang in 2024

No	Actions	Frequency	Percentage (%)
1	Not good	28	24,8
2	Good	85	75,2
	Total	113	100

3.5. Reduction and Sorting of Solid Medical Waste

a. Solid Medical Waste Reduction

Based on observations, the human resources at RSUD Drs. H. Amri Tambunan Deli Serdang have implemented measures to reduce solid medical waste. However, reducing solid medical waste by replacing materials containing hazardous and toxic substances (B3) with non-B3 materials is challenging. This difficulty arises because most materials on the market or from suppliers still contain B3. Furthermore, materials with B3 are often more affordable than those without, prompting management to opt for the cheaper alternatives. Informants indicated that avoiding or minimizing the use of substances or materials containing B3 is not feasible due to the lack of available options. Procuring materials, medicines, and other supplies depends on the purchasing department overseen by management. As a result, staff in the field are limited to using the materials provided. The hospital has complied with medical treatment procedures to help reduce solid medical waste. For instance, if a patient requires a 5 ml drug injection, the syringe will also be 5 ml. Similarly, only that medication will be provided if a patient needs a specific medication (e.g., drug X). Such measures aim to minimize the volume of solid medical waste requiring further management. The planning for the procurement of medicines, other materials, containers, and packaging is typically conducted at the end of the year to meet the needs for the beginning of the following year. The provision of medicines, materials, containers, and packaging depends on the annual budget plan. If funds for these items are not allocated in the current year's budget, procurement will be postponed until the budget for the following year is approved. Decision-making regarding the procurement of medicines and other materials rests with management or the purchasing department. This information is detailed in Table 9.

Table 9. Sorting in Solid Medical Waste Management at Regional General Hospital Drs. H. Amri Tambunan Deli Serdang in 2024

No	Description of Deductions	Available	None
1	Replacing a Mercury Thermometer with a Digital Thermometer	√	
2	Substitute the use of dangerous chemicals with non-toxic materials.		√
3	Using products or chemicals until they run out	√	
4	Recycling used Infusion Bottles	√	
5	Centralize chemical procurement		√

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b. Waste sorting

Based on observations, the human resources at RSUD Drs. H. Amri Tambunan Deli Serdang have sorted solid medical waste into sharps, infectious waste, recyclable solid medical waste, and domestic waste. However, other types of solid medical waste, such as pathological, radioactive, and other medical waste, have not been sorted. The waste sorting process is carried out only by nurses in the respective rooms. The containers or trash bins provided are incomplete and not fully aligned with the types and characteristics of the waste. For instance, sharps waste, which should be disposed of in safety boxes, is often placed in cartons or cardboard instead. Based on field observations, the following illustrates the trash containers/bins provided at RSUD Drs. H. Amri Tambunan Deli Serdang. Details can be found in Table 10 and Figure 1.

Table 10. Sorting in Solid Medical Waste Management at Drs Regional General Hospital. H. Amri Tambunan Deli Serdang in 2024

No	Description of Facilities	Available	None
1	Colored packaging for solid medical and non-medical waste containers/bins is available in each room.		
	a) red for radioactive waste		√
	b) yellow, for infectious waste and pathological waste	√	
	c) purple for cytotoxic waste;		√
	d) chocolate for expired chemical waste, spills, packaging residue, and pharmaceutical waste.		√
2	Symbols are available on medical waste packaging and/or containers.		
	a) radioactive, for radioactive waste;		√
	b) infectious, for infectious waste	√	
	c) cytotoxic, for cytotoxic waste		√
3	Solid medical waste containers/bins are available.		
	a) plastic bags are strong and leak-proof and are given a specific color code	√	
	b) plastic bags are strong and leak-proof and are coded with certain symbols	√	
	c) container	√	
	d) lead (Pb) box bag with radioactive symbol		√

Figure 1. Places or Containers for Medical and Non-Medical Waste at The Regional General

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Hospital Drs. H. Amri Tambunan Deli Serdang

3.6. Storage of Solid Medical Waste

Based on observations, the human resources at RSUD Drs. H. Amri Tambunan Deli Serdang have stored solid medical waste in a designated waste storage facility, specifically in a temporary storage area (TPS) for B3 waste. Table 11 and Figure 2 below detail the TPS for B3 waste.

Table 11. Storage in Solid Medical Waste Management at Regional General Hospital Drs. H. Amri Tambunan Deli Serdang in 2024

No	Description of Facilities	Available	None
1	Emergency response equipment such as APAR is available.	√	
2	First aid facilities are available.	√	
3	Spill handling equipment is available.	√	
4	Loading and unloading facilities are available.	√	
5	The B3 Waste TPS has a refrigerator (refrigerator) to store solid medical waste, especially infectious waste, pathology, and sharp objects if solid medical waste is stored.		√
6	more than 2 (two) days from solid medical waste	√	
7	generated	√	
8	TPS for B3 waste is equipped with a waste container or container that matches the color of the packaging and is equipped with a B3 waste symbol		√

Figure 2. TPS for B3 waste

3.7. Transportation of Solid Medical Waste

The transportation of solid medical waste in this research refers to moving solid medical waste from individual rooms to the B3 waste temporary storage area (TPS). Based on observations, the human resources at RSUD Drs. H. Amri Tambunan Deli Serdang carry out the transportation of solid medical waste from the rooms daily, sometimes even twice a day, or whenever the container is three-quarters full. The waste is then stored in the temporary storage area (TPS) for B3 waste. The storage facility must have refrigeration facilities if the solid medical waste is not processed immediately. Based on observations, infectious, sharp, and/or pathological waste was not stored in a refrigerator, even though the storage period for solid medical waste sometimes exceeded a week. This condition creates the potential for disease vectors to breed and unpleasant odors to develop.

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The floors of the B3 waste TPS should be cleaned and disinfected daily. However, observations revealed that the floors of the B3 waste TPS are not cleaned and disinfected daily, and there is no regular schedule for cleaning the B3 waste TPS. Transportation of solid medical waste uses equipment such as trolleys or carts that are not covered, and the transportation equipment used is rarely cleaned and disinfected daily. The following are solid medical waste transportation equipment available at the research location.

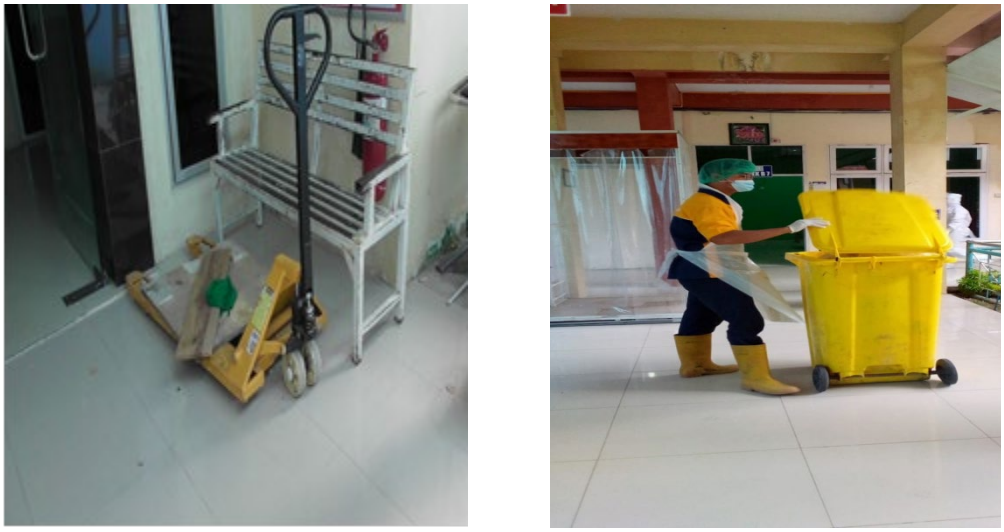

Figure 3. One type of solid medical waste transportation equipment

Hospitals with different waste transportation routes for patients, staff, and visitors face challenges because these routes were not included in the initial building plan, primarily due to limited land availability. Modifying the building site plan to include dedicated waste transport routes would be costly. This issue originated from a lack of understanding among hospital staff and management regarding the requirements for transporting solid medical waste, resulting in the absence of designated waste transport routes in the building design. Without a unique route, waste transportation is typically conducted between 07:00 and 11:00 WIB, when patient and visitor traffic is minimal. Waste handling is not performed correctly or is not using established procedures. Personnel do not use complete personal protective equipment (PPE), such as helmets, face masks, eye protection, aprons, foot protectors, and gloves. The PPE commonly used includes masks, gloves, and safety shoes, with head coverings occasionally worn, though not protective helmets. Based on field observations, the following illustrates officers using PPE at the research location.

Figure 4. Types of PPE used by cleaning staff

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Table 12. Transportation in Solid Medical Waste Management at Drs Regional General Hospital. H. Amri Tambunan Deli Serdang in 2024

No	Description of Facilities	Available	None
1	Waste transport workers use PPE.		
	Helmet		√
	Face mask	√	
	Eye Protection		√
	Apron/apron	√	
	Foot/shoe protectors		√
	Gloves	√	
2	There is a procedure for using PPE before work, and it is installed in the room.		√
3	Solid medical waste transport equipment is available with the following criteria:		
	Easy to clean	√	
	Waterproof	√	
	Closed	√	
	Equipped with color and waste code	√	
	Disinfection is carried out regularly.	√	
4	Transport equipment is in good condition and does not leak.	√	
5	There are roads for transporting waste that differ from the public roads used by patients and/or hospital visitors.		√

3.8. Solid medical waste processing

Based on observations, the methods used for processing solid medical waste at RSUD Drs. H. Amri Tambunan Deli Serdang include chemical disinfection and incineration. Not all medical waste is handed over to B3 waste management companies. Sharp and infectious waste is processed using an incinerator, while used IV bottles, HD jerry cans, and plastic materials are recycled and sold to other companies.

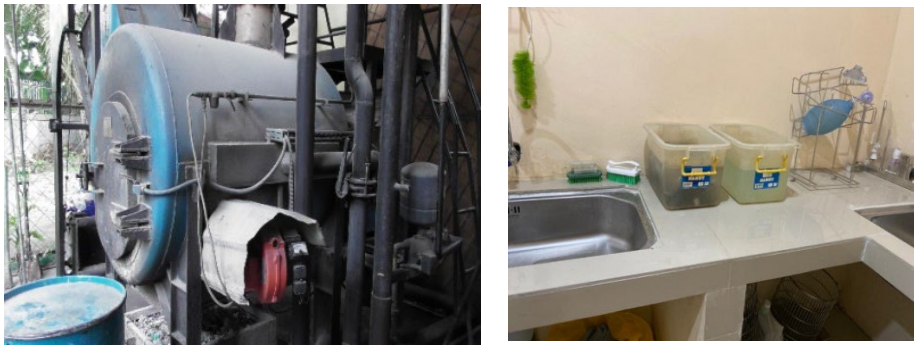

Figure 5. Incinerator and Chemical Disinfection

3.9. Discussion

The research results show that most nurses, environmental health officers, and cleaners have poor knowledge of solid medical waste management, with 61.1 percent falling into this category. This lack of knowledge could be attributed to most of these staff members (93%) working for only 1 to 10 years, suggesting that good knowledge typically develops through job experience. This finding is supported by Nugraha and Suryandari (2018), who state that individuals with more experience tend to acquire more excellent knowledge over time. It is also consistent with Mirayanti and Juanamasta (2020), who explain that

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knowledge results from learning after a person senses a particular object. This sensing can occur through sight, smell, hearing, taste, or touch, with most human knowledge acquired through the eyes and ears.

Most nurses, environmental health officers, and cleaners demonstrated good attitudes toward waste management, with 100% falling into the good category. This positive attitude is supported by age, maturity, education level, and length of service. Most nurses, environmental health officers, and cleaners are between 19 and 35 years old, which is categorized as the productive age group. This finding aligns with previous research, which shows that most workers are in the 20–30 age range, classified as young. This age group tends to dominate jobs that do not require specialized skills due to their peak energy levels (Aliyah & Utami, 2022). Age influences a person's behavior, as older individuals tend to exhibit greater maturity in thinking and working (Kanfer & Ackerman, 2004). Similarly, Maulana (2018) stated that a person's tendency to respond positively or negatively to certain people, situations, objects, or things depends significantly on age maturity. Length of service also affects an individual's attitude. A longer working period leads to a more cautious approach to tasks and a greater likelihood of adhering to workplace rules (Wawan & Dewi, 2010).

The research results indicate that most actions taken by nurses, environmental health officers, and cleaners in managing solid medical waste are in a suitable category, with 85% exhibiting good practices. These positive actions are influenced by age, education, and length of service (Boumans et al., 2011). Knowledge and positive attitudes lead to good actions. Ajzen et al. (2018) suggest that behavior is shaped by individuals who possess knowledge about objects, encouraging attitudes, and motivating actions. Behavior can be measured based on attitudes or actions. According to previous research by Yanik et al. (2019) at Jember City Hospital, effective solid medical waste management is significantly influenced by the education, knowledge, and supervision of waste management staff behavior. This implies that sound human resource behavior translates into effective medical waste management. The study highlights that improving education and knowledge alone is insufficient for managing solid medical waste. Routine monitoring, both internal and external, within hospitals is equally essential. The success of medical waste management heavily depends on the behavior of the staff responsible for managing solid medical waste. Regular training on medical waste management for healthcare workers is essential to enhance their understanding, attitudes, and actions in handling solid medical waste. Behavior shaped through education and training significantly improves staff comprehension and practices in managing solid medical waste.

Previous research has shown that behavior is closely related to waste disposal practices. Internal factors, such as awareness, knowledge, and a sense of responsibility, are strongly linked to proper waste disposal behavior (Allen, 2024). Another improper practice is failing to store solid medical waste in a refrigerator, even when the storage period exceeds two days. This aligns with previous research, which found that one-third of doctors and nurses demonstrated poor waste disposal practices compared to those who had received training. Nurses and doctors who have attended training tend to exhibit greater confidence and positive attitudes toward proper waste disposal practices (Amfo-Out, 2018). Good knowledge and attitudes toward waste management must be accompanied by a high level of awareness among all human resource elements to encourage individuals to practice proper waste management consistently. Awareness becomes ingrained when individuals recognize the benefits and the importance of adhering to established rules. Instilling this awareness among healthcare workers, doctors, nurses, cleaners, and waste management staff must be carried out continuously through education and skill enhancement, such as training programs. Ilyas et al. (2019) support this view, emphasizing that continuous training is essential for healthcare workers to understand waste management regulations, develop effective policies, and improve compliance among waste management officers and other human resource elements. Another practical approach to strengthening staff behavior is conducting briefings before work shifts. These briefings help foster enthusiasm, teamwork, and a shared commitment to creating a safer and healthier work culture.

The types of solid medical waste generated by hospital activities include infectious waste, sharp objects, pathological waste, cytotoxic waste, radioactive waste, pharmaceutical waste, expired chemical waste, spills or residual packaging, medical equipment with high heavy metal content, and gas cylinders or pressurized containers. This aligns with previous research by Ali et al. (2017), which categorized hospital

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medical waste into hazardous types, including infectious waste, pathological waste, sharp objects, pharmaceutical waste, genotoxic waste, chemical waste, and radioactive materials. At RSUD Drs. H. Amri Tambunan Deli Serdang, the average daily amount of infectious waste, sharp objects, and pathological waste generated across service units (inpatient rooms, installations, polyclinics, and other units) is approximately 86.41 kilograms per day, totaling around 2,678.71 kg/month. This includes 10.45 kg/day of sharp waste, 75.65 kg/day of infectious waste, and 0.31 kg/day of pathological waste. The volume of waste is closely related to the increase in the number of treated patients and the use of personal protective equipment (PPE), which contribute to higher solid medical waste production. This finding is consistent with research by Alauddin and Imam (2022), which examined the correlation between patient numbers and solid medical waste volume in Sidoarjo hospitals. The study revealed a significant positive relationship: as the number of patients increases, the volume of solid medical waste also rises.

The initial stage of solid medical waste management involves reducing and sorting waste at each service unit. Proper separation and sorting of solid medical waste play a crucial role in minimizing waste volume and enabling the implementation of environmentally friendly waste processing technologies (Ali et al., 2018). An increase in the number of patients directly correlates with increased waste volume. If hospitals establish clear regulatory obligations for each medical service unit—from registration to polyclinics, inpatient rooms, pharmacies, and other departments—this policy can reduce waste volume at its source. However, these regulations must be supported by strict and continuous supervision and efforts to identify and implement alternative environmentally friendly materials through ongoing studies and research. One of the efforts to reduce solid medical waste at RSUD is through recycling. Drs. H. Amri Tambunan Deli Serdang. Types of medical waste that are recycled include used infusion bottles, used hemodialysis fluid packaging, syringe bodies, glass bottles, and used plastic medicine bottles. The recycling process begins with sorting recyclable waste directly from service rooms. The waste is transported by cleaning service staff to the hospital's waste processing site. Waste management staff disinfect the waste at the processing site by spraying it with a 5% chlorine solution. The waste is then chopped or cut using knives or cutters and soaked in a tub containing a 5% chlorine solution for 30 minutes. After soaking, the waste is washed in a tub filled with clean tap water, dried under the sun, and stored in boxes or cardboard. Finally, the waste is weighed and sold to authorized recycling companies.

The waste sorting process must be supported by waste bin facilities that align with the type and characteristics of the waste. The color coding for waste containers or packaging must include four categories: red for radioactive waste, yellow for infectious and pathological waste, purple for cytotoxic waste, and brown for expired chemical waste, spills, packaging residues, and pharmaceutical waste (Minister of Health Regulation No. 7 of 2019 and Permenlhk No. P.56/Menlhk-Setjen/2015). This is consistent with Liana's (2012) research, which found that yellow bins are designated for infectious waste. However, based on field observations, the hospital's waste bins are incomplete. Only three bins are available: safety boxes for sharps waste, yellow bins for infectious waste, and black bins for domestic waste.

The process of sorting solid medical waste has not been carried out correctly. This is evidenced by the continued mixing of sharps waste with other medical waste in yellow plastic containers. Such improper sorting increases the risk of leaks, which can potentially injure staff during the transportation and processing of waste. Separating, storing, and processing medical waste are closely tied to behavioral aspects, indicating that challenges in reducing and separating medical waste are related to healthcare workers' understanding and attitudes toward waste management. Efforts to improve staff knowledge, attitudes, and actions are primarily carried out through regular training (Putra et al., 2017). Previous research also highlights that training significantly enhances the knowledge of waste management officers (Maharani A. et al., 2017). However, no waste processing officers have participated in training in hazardous and toxic (B3) waste management. Such training has only been attended by the chief environmental health officer. Additionally, the transportation of solid medical waste to the B3 waste temporary storage facility (TPS) does not fully comply with applicable regulations. Waste transportation is performed by cleaning service staff, who must wear complete personal protective equipment (PPE). However, not all staff members use proper PPE due to the absence of clear rules

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or standard operating procedures (SOPs) regarding PPE usage and the lack of adequate PPE supplies in the hospital. Medical waste was not transported twice a day as scheduled because waste transport officers were occasionally absent, leading to a buildup of medical waste in the rooms. Therefore, there is a need for a specific Standard Operating Procedure (SOP) for waste transport personnel. The existing SOPs must comply with the Minister of Health of the Republic of Indonesia Number 7 of 2019's Regulation concerning Hospital Environmental Health. Similarly, previous research has found that transporting solid medical waste in hospitals often faces delays. In some cases, waste was not transported on the scheduled day due to factors such as holidays, traffic jams, or damage to the incinerator machine (Haryanto et al., 2021). Waste transportation equipment plays a crucial role in managing solid medical waste. This is supported by research from Nursamsi et al. (2017), which identified waste transportation equipment as one of the key factors for solid medical waste management success. The equipment for transporting solid medical waste includes open trolleys or trash carts. However, these transportation tools are not disinfected daily, increasing the risk of disease transmission. Sometimes, trash cans and trolleys are handled by staff, which can result in medical waste being scattered on the floor or around the B3 waste TPS locations. This creates a hazard for contamination and increases the risk of injury, such as from syringes, and facilitates the spread of disease to patients, staff, and hospital visitors. This aligns with WHO regulation in 2023, which emphasizes that trolleys and rubbish bins must be disinfected daily to prevent disease contamination. After sorting, the waste is collected in containers and stored in a temporary storage area (TPS) for solid medical waste. The requirements for the storage facility include a tight concrete or cement floor with a proper drainage system and a water source for cleaning. The location of the TPS for B3 waste must be easily accessible to waste handling staff, free from flooding, and protected from direct sunlight and rain. Additionally, the TPS should be secure from access by insects, birds, or other animals. Plastic bags or trash containers should be located near the B3 waste TPS, and personal protective equipment (PPE) must be available. The B3 waste TPS should also have refrigeration facilities if solid medical waste is not processed immediately. According to PMK No. 7 of 2019 and Minister of Environment and Forestry Regulation No. P.56/Menlhk-Setjen/2015, B3 waste TPS must be cleaned within 24 hours and refrigerated when the storage period exceeds 48 hours. However, non-compliance with these regulations has been observed, as some B3 waste TPS are not cleaned within 24 hours and lack refrigeration facilities, even when the storage period exceeds 48 hours. This is due to a lack of awareness among officers and the absence of routine supervision from hospital management.

The facilities used for transporting solid medical waste, including elevators, are currently the same public routes and elevators used by healthcare workers, patients, and visitors. There should be a separate transportation route for medical waste to prevent the risk of disease contamination. This aligns with research by Johannessen et al. (2020), emphasizing that hospitals must have dedicated routes for transporting solid medical waste. Based on observations, sharp and infectious waste processing at the research location uses incinerators and chemical disinfection. B3 waste management service companies handle the management of cytotoxic and radioactive waste. External service providers also properly manage pharmaceutical waste, expired chemical waste, gas cylinders, or pressurized containers. The medical waste processing activities using chemical disinfection have not received approval from the Deli Serdang Environmental Agency (DLH), according to Permenlhk No. P.56/Menlhk-Setjen/2015, medical waste processing by healthcare facilities must be authorized by the local city or district DLH. This oversight occurred because management was unaware that such waste processing activities require a permit.

IV. Conclusion

1. The knowledge of nurses, environmental health officers, and cleaners in managing solid medical waste falls into the "good" category, with 61.1%. Demonstrating strong knowledge. This level of expertise is likely because most of these staff members (93%) have worked for 1 to 10 years, meaning their experience contributes significantly to their understanding of water management.

2. The attitudes of nurses, environmental health officers, and cleaners are also in the "good" category, with 100% displaying positive attitudes toward waste management. This positive attitude is influenced by age, education level, and length of service. Most nurses, environmental health officers, and cleaners are between 19 and 35 years old, falling within the productive age range.
3. The actions of nurses, environmental health officers, and cleaners in managing solid medical waste fall into the "good" category, with 85% demonstrating proper actions. These positive actions are influenced by factors such as age, education, and length of service.
4. The management of solid medical waste at Drs. Starting from the reduction and sorting process, H. Amri Tambunan Deli Serdang Regional General Hospital still relies on chemical products for cleaning. The storage at the B3 waste temporary storage area (TPS) does not include refrigeration facilities when solid medical waste is stored for more than 2 days after being produced. During transport, officers are still not wearing complete personal protective equipment (PPE), such as helmets, face masks, eye protection, aprons, foot protectors, and gloves. Additionally, the use of chemical disinfection for waste processing has not received approval from the Environmental Service. The hospital has also not provided a designated transportation route for solid medical waste. Based on these findings, the management of solid medical waste does not fully comply with the Ministry of Environment and Forestry Regulation Number P.56/Menlhk-Setjen/2015.

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