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# Structural Equation Model of Hazardous Medical Waste Management of Health Centers in Solok District Indonesia

Luthfil Hadi Anshari[1], Eri Barlian[2], Indang Dewata[3], Tuty Ernawati[4]

**Abstract**

*Discussing the Medical Hazardous Waste Management Model in the Solok Regency Health Office Work Area in 2023, the behavior of officers is very decisive in the management of medical hazardous waste which will be able to cause nosocomial infectious diseases in health workers, patients and visitors and the surrounding community because it contains disease agents in the form of infectious waste, toxic chemicals, and radioactive. This study is an analytical study with quantitative methods with the aim of obtaining information on the factors that influence the management of hazardous and toxic medical waste at health centers in Solok Regency. To test the research hypothesis, a one-way statistical t test was used with a t value of 1.96 with an alpha confidence degree of 5%.In the overall results, it can be seen that all variables in the path analysis, namely sorting, packaging and transportation, are able to influence hazardous waste management efforts in explaining the variance of each variable by 89.5% and there is a value of 10.5% explained by other factors. Based on the results of path analysis using the SEM method, it is found that sorting directly and indirectly affects the management of hazardous waste at the public health centers (public health center) with a total effect of: 2,331. The results of the path analysis using the SEM method found that storage indirectly affects the management of hazardous medical waste Public health center waste with a total effect (β) of: 1.896, packaging directly affects the management of hazardous waste health centers with a total effect (β) of: -0.185 and transportation directly affects the management of Public health center hazardous waste with a total effect (β) of : 0,590.*

***Keywords:*** *Hazardous Medical Waste.*

## INTRODUCTION

Hazardous waste from health services is also called hazardous medical waste which is the residue of a business or activity that contains hazardous or toxic materials which, due to their nature, concentration, and amount, especially infectious waste, can directly or indirectly pollute and damage the environment and can endanger health, human survival, and living things and are very potential in transmitting infectious diseases (5). Medical hazardous waste can be in the form of infectious waste, pathology waste, sharps waste, pharmaceutical waste, cytotoxic waste, chemical waste, radioactive waste, pressurized container waste and waste containing high heavy metals(6). Moreover, with the outbreak

[1] Postgraduate Environmental Science Doctoral Program, Padang State University, Indonesia, luthfilhadi2023@gmail.com
[2] Postgraduate Environmental Science Doctoral Program, Padang State University, Indonesia, e.barlian@fik.unp.ac.id
[3] Postgraduate Environmental Science Doctoral Program, Padang State University, Indonesia, indangdewata@fmipa.unp.ac.id
[4] Faculty of Public Health, Andalas University, Indonesia

of the COVID-19 pandemic, the volume of medical waste generation has increased significantly (7).

The management of hazardous medical waste at health centers has quite complex problems considering the limited resources owned by health centers. In addition, the location of health centers is generally in a fairly dense population environment, which will facilitate the emergence of pollution to the community around the health center environment with the presence of waste, both solid waste and liquid waste discharged into public channels. For this reason, the management of hazardous medical waste must be planned and implemented properly in accordance with the guidelines set by the government. The management of medical hazardous waste is carried out with the principle of vigilance by using safe and environmentally friendly waste management methods (9). Safe and correct management of hazardous waste is an obligation that must be carried out by every health care facility in accordance with applicable standards and regulations. (Permenlhk no. p.56/2025) Improper management of medical waste can cause environmental pollution, increase the incidence of disease transmission such as hepatitis due to sharp objects contaminated with human blood (Abdulla Fayez 2008).

In addition to the local government's efforts in handling hazardous medical waste, the active role of health center staff is also needed to reduce the problem of health service waste, especially hazardous medical waste. The participation is mainly related to the behavior of officers to manage medical hazardous waste starting from each room/work unit that is generated by themselves at the public health centers (public health center). Such behavior will emerge if health center staff have good knowledge and understanding of medical hazardous waste management. Officers' knowledge will determine their attitudes and actions in handling various matters including participation in managing medical hazardous waste. A proper understanding of medical waste will influence the officers' behavior in managing it.

According to data from the Ministry of Health of the Republic of Indonesia, there are 2856 hospitals, 10,062 health centers and 8,547 clinics in Indonesia, only a small number of which have carried out medical hazardous waste management according to standards, such as those that already have licensed incinerator facilities, only 88 health facilities. There are only 12 companies engaged in medical hazardous waste management and only one company in Sumatra (10).

According to the Directorate General of Public Health of the Ministry of Health (2019), solid medical waste generation in health care facilities, especially hospitals and health centers, is 296.86 tons / day. So there are still as much as 69.84 tons / day of medical hazardous waste that has not been managed properly, an even more difficult situation is in areas far from the capital such as in districts where health centers are spread far enough and some are difficult to visit by vehicle (11). So far, public health center can cooperate with hospitals to incinerate medical hazardous waste, but currently in West Sumatra there are no hospitals that are licensed to incinerate medical hazardous waste,

The Governor of West Sumatra stated that there are 1,899.15 tons of hazardous and toxic medical waste from 2,839 health facilities in West Sumatra per year. He also informed that hospitals or other health facilities should not dispose of medical waste carelessly.

The results of an evaluation of medical waste handling in Brazil stated that the lack of knowledge of officers about waste handling regulations led to the mixing of medical and non-medical waste and the discrepancy between handling practices and established regulations (Moreira & Günther, 2013). Furthermore, another study found shortcomings and weaknesses in the handling of medical waste in the sorting and temporary storage of medical waste (Omar, Nazli, & Karuppannan, 2012). Zheng's research (2016) stated that in China there are also weaknesses in handling medical waste, namely not carrying out sorting, temporary storage, lack of regulations and facilities for sorting medical waste.

Information obtained through interviews with the sanitation officer of the Solok Regency Health Office is that there are still waste pick-ups to public health center more than once every 3 months and even more than 6 months, besides that Solok Regency does not yet have a special warehouse and special vehicles to accommodate medical hazardous waste from public health center, so that third parties must directly pick up the public health center, this is constrained again because the location of public health center is spread quite far in Solok Regency with poor geographical conditions as well. If there are facilities, the health center staff will certainly carry out medical waste management properly according to the rules, but because there are no facilities available, there are still officers who are less concerned about sorting properly according to the type of waste. Not to mention the containers and storage rooms for medical hazardous waste that are not in accordance with the rules.

In the preliminary survey at two public health center, namely the long alahan public health center and the Singkarak public health center, it was found that the management of hazardous medical waste at the public health center was not fully managed properly, there was still medical waste mixed with general waste, storage that was not in accordance with the rules and the late pick-up of medical waste by third parties for more than six months.

Based on the description above, the researcher is interested in discussing the Medical Hazardous Waste Management Model in the Solok Regency Health Office Work Area in 2023, the behavior of officers is very decisive in the management of medical hazardous waste which will be able to cause nosocomial infectious diseases in health workers, patients and visitors and the surrounding community because it contains disease agents in the form of infectious waste, toxic chemicals, and radioactive.

## METHODS

This study is an analytical study with quantitative methods with the aim of obtaining information on the factors that influence the management of hazardous and toxic medical waste at public health center in Solok Regency. The data obtained is used to find a model for strengthening the capabilities of health center staff in managing appropriate medical hazardous waste, which can be used in all health centers in Solok district in particular and West Sumatra in general. This research was conducted in November 2020 at health centers in the Solok district working area. Primary data was obtained by direct observation to the location or object of research as well as conducting direct discussions and interviews while secondary data was obtained from health center data related to hazardous medical waste. The research sample amounted to 168 people in 19 health centers. Data analysis was carried out in 2 stages, namely descriptive analysis to explain the characteristics of each research variable. Descriptive analysis on all research variables by determining frequency, mean, and standard deviation. The data collected, processed and analyzed using a computer and presented in tabular form and interpreted and then inferential analysis using the Structural Equation Model using Smart-PLS3.0 software to test the research model on the management of medical hazardous waste generated at public health center. To test the research hypothesis, a one-way statistical t test was used with a t value of 1.96 with an alpha confidence degree of 5%.

## RESULTS

1. Structural Equation Model Analysis

The results of data analysis using structural equation modeling (SEM) in efforts to manage hazardous waste at the Public health center. To get the value of the variables to be studied, each observed variable is first computed based on its group in SEM which is

called the loading factor value. The correlation value is the result of analysis with the conceptual model being the benchmark for comparison.

Variable Composite with Confirmatory Factor Analysis (CFA)

For this variable composite, it is intended to see the validity or invalidity of data on observed variables in latent / unobserved variables or how much indicator variance can be explained by latent variables. In research that is still in the development stage or testing the theory, the standard value for the composite value or loading factor is met, namely using a tolerance value greater than 0.7 (Hengky, 2013).

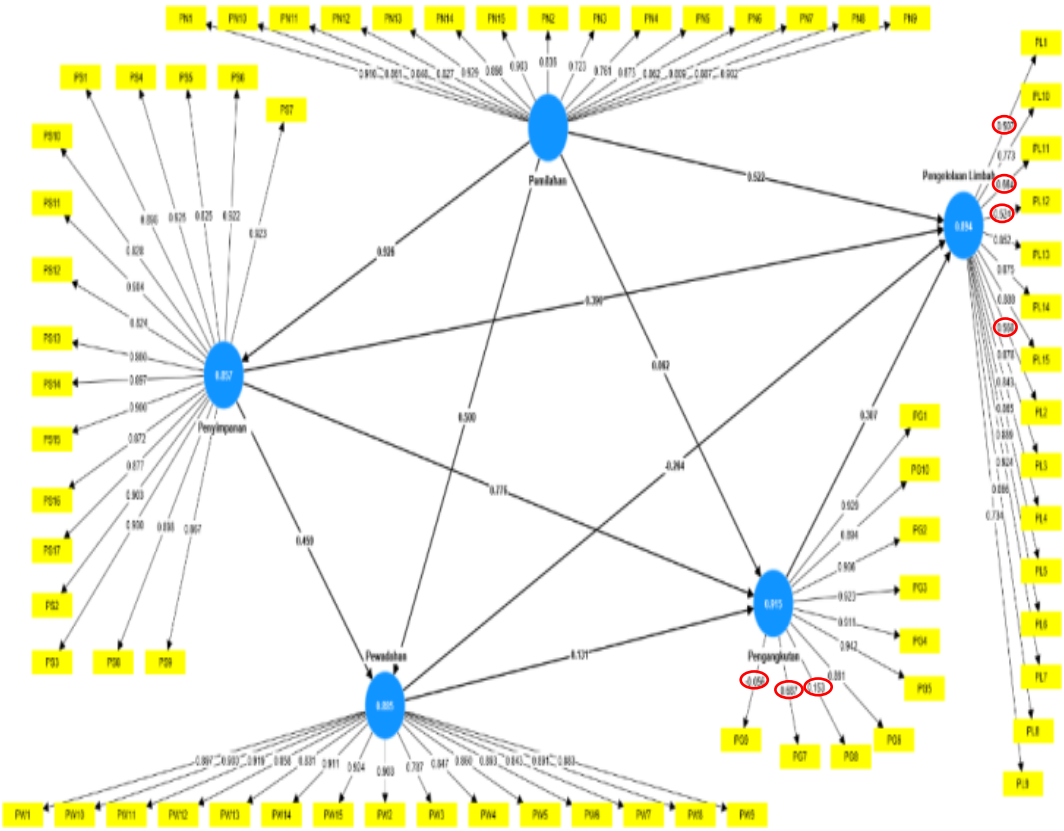


Figure 1: Loading Factor Value for Each Variable

In Figure 1, information is obtained from the loading factor value of each independent variable and the dependent variable, namely:

1. In the sorting variable, it is obtained that all loading factor values are significant as indicators of hazardous waste sorting at the Public health center of the Solok District Health Office work area because they have a loading factor value> 0.7.

2. In the storage variable, it is obtained that all loading factor values are significant as indicators of hazardous waste storage at the Public health center of the Solok District Health Office working area because they have a loading factor value> 0.7.

3. In the packaging variable, it is obtained that all loading factor values are significant as indicators of hazardous waste packaging at the Public health center of the Solok District Health Office working area because they have a loading factor value> 0.7.

4. In the transportation variable, it is obtained that of the 10 sub-indicators, there are 7 sub-indicators as a significant loading factor value on the indicator of hazardous waste storage at the Public health center of the Solok District Health Office working area because it has a loading factor value> 0.7.

5. In the hazardous waste management variable, information is obtained that of the 15 sub-indicators, there are 11 sub-indicators as a significant loading factor value on the

hazardous waste management indicator at the Public health center of the Solok District Health Office work area because it has a loading factor value> 0.7.

The results of analysis using the Structural Equation Modeling (SEM)

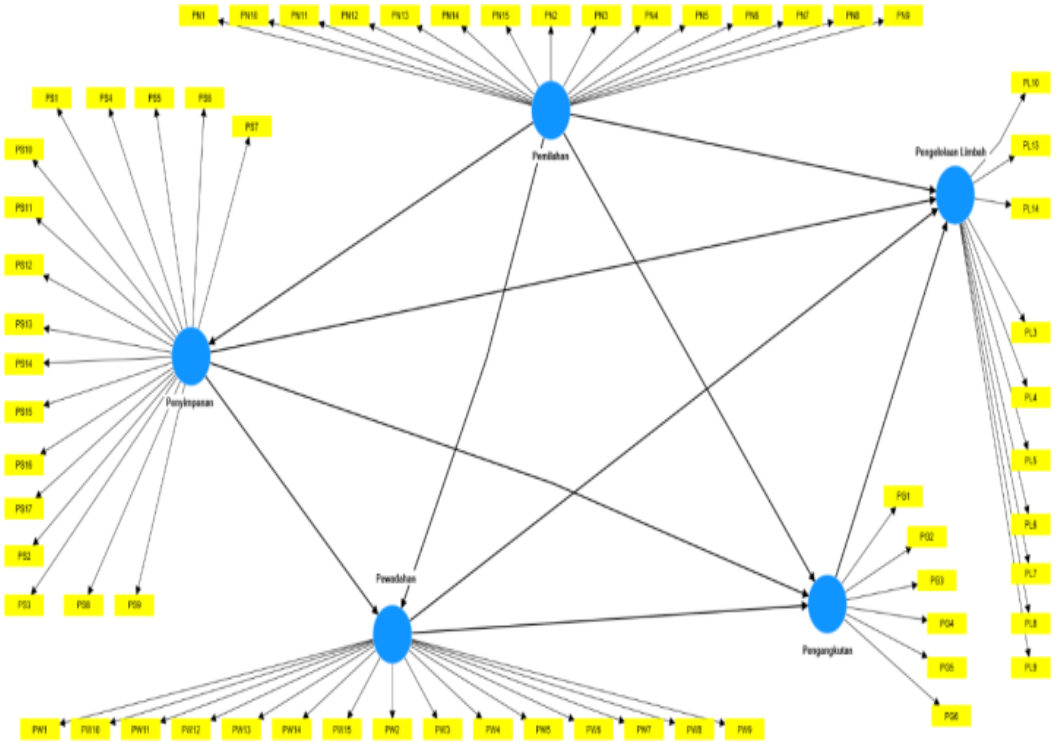


Figure 2: Structural Equation Modeling Design on Hazardous Waste Management

In the results of this analysis, the observed variable data / invalid loading factor values have been eliminated so that only valid data appears from the observed variable values so that a large value of influence is obtained. This can be seen in Figure 3.

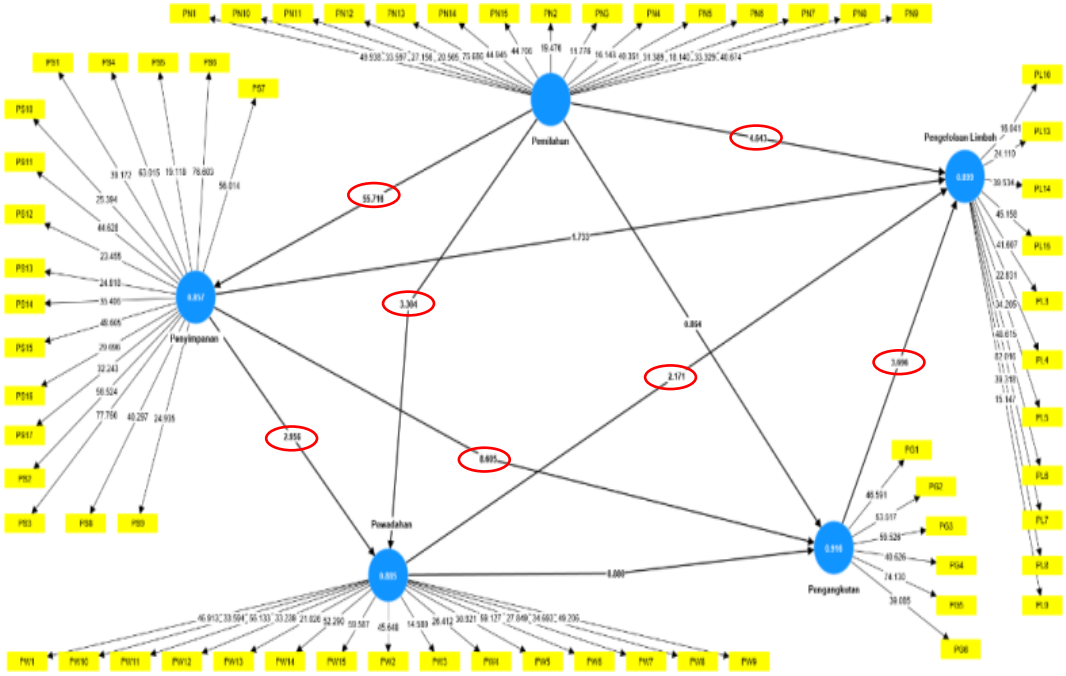


Figure 3: Path coefficient value / magnitude of influence of hazardous waste management

After obtaining the results of the magnitude of the influence in Figure 3, the next figure shows the T-value of the Public health center hazardous waste management efforts in order to obtain the significant value of each variable.

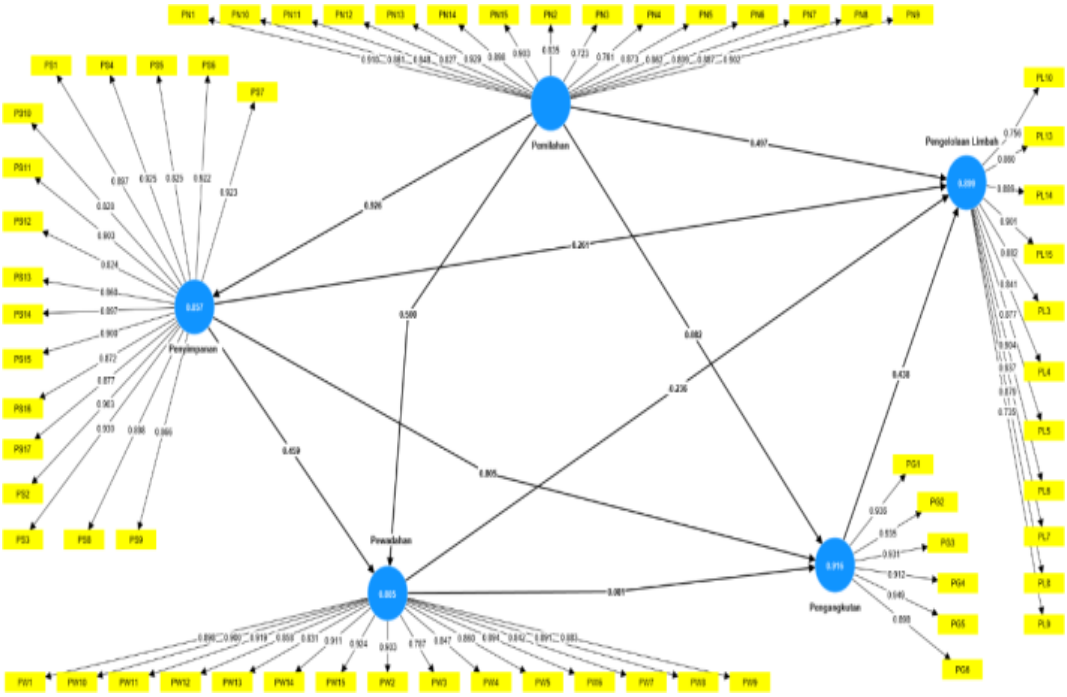

Figure 4 Significance Level Value (T-Value) in Medical Hazardous Waste Management Efforts

In accordance with Figure 3, the structural equation is obtained

$Y: P_{yx1} X_1 + P_{yx3} X_3 + P_{yx4} X_4 + \varepsilon$ ;

R*square*: $0{,}497X_1 + (-0{,}236X_3) + 0{,}438X_4 + 0{,}101$; 0,899.

After obtaining the SEM analysis results according to Figure 4, the results are displayed in Table 1, namely:

Table 1: Path Coefficient Results and Significant Levels

| Influence between Variables | Coefficient of Path (beta) | T - Value | Test Result |
|---|---|---|---|
| Storage (X2) on Hazardous Waste Management (Y) | 0,497 | 4,643 | Significant |
| Containerization (X3) on Hazardous Waste Management (Y) | 0,261 | 1,733 | Not Significant |
| Transportation (X4) to Hazardous Waste Management (Y) | -0,236 | 2,171 | Significant |
| | 0,438 | 3,696 | Significant |

Based on figures 3 and 4, the results of the path coefficient and the level of significance are obtained as an effort to manage hazardous waste at the Public health center. For the T-value, it is said to be significant if the T-value> 1.96. From this data, it is found that there are factors that affect and factors that do not affect hazardous waste management. For more details can be seen in table 1. This is obtained, namely:

a. Segregation (X1) on Hazardous Waste Management (Y)

Based on table 4.6, the statistical test results of path analysis with the SEM method obtained a T-value of 4.643 with a confidence level of 95%. The value of 4.463> 1.96. This shows that sorting has a significant effect on hazardous waste management. Sorting has a path coefficient (β) of 0.497 on hazardous waste management. This shows that the better the sorting carried out by the Public health center, the better the management of hazardous waste at the Public health center by 49.7% and vice versa.

The sorting of medical hazardous waste has been carried out in all public health center in Solok Regency, but not all public health center are in accordance with the requirements for sorting. There are still containers used by public health center that do not meet the standards, especially from the plastic lining which will be used to collect waste from the room to the storage room, especially in the storage room for a long time located and stacked continuously, so that the plastic can be torn., If this plastic bag is taken to a place or collection depot there could be splashes of waste or liquid both in transportation and at the time of transfer to the container that is already available in Kota Baru.

Based on the results of the T-Value test, it can be seen that sorting has a significant influence on the management of medical hazardous waste, the better the sorting process, the better the waste management process.

Based on table 1, the statistical test results of path analysis with the SEM method obtained a T-value of 4.643 with a confidence level of 95%. The value of 4.463 > 1.96. This shows that sorting has a significant effect on hazardous waste management. Sorting has a path coefficient (β) of 0.497 on hazardous waste management. This shows that the better the sorting carried out by the Public health center, the better the management of hazardous waste at the Public health center by 49.7% and vice versa.

According to Permenlh no. p.56 of 2015, it is explained that sorting is carried out by separating hazardous medical waste based on the type, group, and/or characteristics of hazardous medical waste and containerizing hazardous medical waste according to the hazardous medical waste Waste group. Segregation is an important stage in Waste management. Some important reasons for segregation include a. Segregation will reduce the amount of Waste that must be managed as hazardous Waste or as medical Waste because non-infectious Waste has been segregated; b. Segregation will reduce Waste because it will produce a solid waste stream that is easy, safe, cost-effective for recycling, composting, or further management; c. Segregation will reduce the amount of hazardous Waste that is disposed of with non-hazardous Waste into environmental media. An example is separating mercury so that it is not disposed of with other non-Hazardous Waste; and d. Segregation will facilitate the assessment of the amount and composition of various waste streams, enabling healthcare facilities to have a database, identify and select cost-effective waste management efforts, and assess the effectiveness of waste reduction strategies.

Seeing the influence of this waste sorting on waste management, the sorting system should be carried out based on medical and non-medical waste, where the waste is labeled so that officers know to dispose of waste based on its type. The sorting process is carried out to make it easier for health workers to handle the waste generated so that the next process/stage will be easier. Segregation is the first process in health center waste management. Sorting should be done as close to the source as possible.

Based on the results of path analysis using the SEM method, it is found that sorting directly and indirectly affects the management of hazardous medical Public health center waste with a total effect of : 2,331.

For Waste sorting efficiency and reducing the use of inappropriate packaging, placement and labeling on packaging must be done appropriately. Placement of packaging side by side for non-infectious waste and infectious waste will result in better waste sorting.

b. Storage (X2) on Hazardous Waste Management (Y)

Based on interviews and direct observations at Public health center se, for the Solok Regency process, the waste storage process is carried out storage, some already have cold storage but the volume is limited, so that the overflow from waste is stored in the room along with other used goods, while those that do not have cold storage medical waste is stored in a special room but there is also nothing that meets the requirements in accordance with the rules, where waste is placed directly on the floor. Some are put in

drums or containers such as large and closed buckets, but there is still waste located outside the container. and safety boxes for syringe waste, but there is still a lot of syringe waste, cotton swabs used for actions that are not placed in safety boxes and generally there is no label or symbol for storing infectious waste. The storage time for waste is not certain, the fastest is every 3 months and some are even up to 6 months.

All medical waste must be stored and collected at a temporary storage location until it is transported to the processing location. The storage location is marked. The storage location must be fixed, away from patient rooms, laboratories, operating rooms, or areas accessed by the public. In a study conducted by Gloria Mayonetta on the Evaluation of Hazardous Solid Waste Management of Public health center Facilities in Sidoarjo Regency in 2016, it was stated that the storage of hazardous solid waste by the Main Public health center in the hazardous medical waste temporary disposal site was carried out for months. Likewise, research conducted by Mayonetta (2015) There is a buildup of medical hazardous waste for a long time at the Public health center in Sidoarjo Regency similar to what happened at the Tobelo Health Center.

Based on the results of path analysis using the SEM method, it is found that storage indirectly affects the management of hazardous medical waste at the Public health center with a total effect (β) of : 1,896. The process of storing waste in a special room is clearly influenced by sorting and packaging, so storage has no effect on the management of medical hazardous waste.

For this reason, although this storage process does not have a direct effect on waste management, it must still be a concern for the person in charge of hazardous waste management at the health center because the transportation time is quite long, up to 3 - 6 months, meaning that there will be accumulation and liquid splashes on the floor, so it is necessary to clean up every time the waste is transported.

c. Dumping (X3) on Hazardous Waste Management (Y)

Based on the observations, all medical solid waste is mixed with various other medical solid wastes, while sharp wastes such as used injections are collected using safety boxes. The containers used are from plastic containers that have lids, but some are still using uncovered containers, only covered with plastic. The plastic lining of the container is directly used for waste storage when it is 2/3 full and tied up and taken to the storage room. The type of plastic provided in the form of assistance from the Solok District Health Office meets SNI with a yellow color, in some health centers this plastic bag assistance is insufficient, so the shortage, the plastic is bought from ordinary stores, so it does not meet the standards, because it is easy to leak and tear. The containers have not all attached hazardous waste symbols and labels.

Based on table 1, the statistical test results of path analysis with the SEM method obtained a T-value of 2.171 with a confidence level of 95%. The value of 2.171 > 1.96. This shows that containerization has a significant effect on hazardous waste management. Shedding has a path coefficient (β) of -0.236 on hazardous waste management. This shows that the better the packaging carried out by the Public health center, the better the efforts to reduce hazardous medical waste at the Public health center by 23.6% and vice versa.

Hazardous Waste Packaging is a way of placing or containerizing hazardous waste so that it is easy to store and/or collect and/or transport hazardous waste so that it is safe for the environment and human health. In each source/room, containers are placed according to the waste produced. The container is named according to the waste category/group and given a plastic bag according to the color. Syringes can be provided with a safety box at the place of action. After injecting, the syringe is immediately inserted into the safety box without closing it again. Syringes can also use a needle cutter or needle destroyer to separate the siringe from the spoit.

In accordance with Permenkes RI 1204 / MENKES / SK / X / 2004 concerning hospital environmental health requirements, namely sharp objects should be accommodated using a safety box or made of strong material. The use of strong materials in collection is used so that sharp objects cannot penetrate outside because if sharp objects such as syringes penetrate the collection site, of course, it will cause puncture to health workers who handle the medical waste.

According to Chandra (2006), waste storage is divided according to its category, both plastic wrapping and waste storage containers. For clinical waste such as infectious waste, the containment bag is yellow with a biohazard symbol. In this study, the use of yellow plastic with a biohazard symbol was not done. This study is in line with research conducted by Kabir et all (2004), where the results of the study said some hospitals in Iran did not use yellow plastic infectious waste.

Based on the results of path analysis using the SEM method, it is found that the container directly affects the management of hazardous waste at the health center with a total effect (β) of : -0,185. The internal transportation process is carried out by the cleaning service every day to be taken to the temporary shelter. The activity is carried out manually without using tools on the grounds that the amount of waste transported is not large.

This containerization process has not been carried out by all health centers according to the standard, so for this reason, plastic procurement should be planned according to the needs of a year by the health center, and for shelter containers to pay attention to the types that have been recommended by the Ministry of Health and the containers used must also be cleaned after being emptied from the previous buildup.

d. Transportation (X4) to Hazardous Waste Management (Y)

All public health center carry out transportation by puskel to the depot waiting for waste from each public health center located in Kotabaru, Kubung District, Solok Regency. This clearly does not meet the requirements, this is because the third party does not pick up to the public health center due to the long distance. The use of puskel for the transportation of hazardous medical waste is clearly very dangerous because if the ambulance car is not sterile, there is a possibility of transferring germs to patients.

Based on table 1, the statistical test results of path analysis with the SEM method obtained a T-value of 3.696 with a confidence level of 95%. The value of 3.696> 1.96. This shows that transportation has a significant effect on hazardous waste management. Transportation has a path coefficient (β) of 0.438 on hazardous waste management. This shows that the better the transportation carried out by the Public health center, the better the hazardous medical waste management efforts at the Public health center by 43.8% and vice versa.

According to Chandra (2006), the vehicle used must meet the requirements in terms of ease of use and cleaning, as well as being equipped with a leak collection device. In waste transportation vehicles, the driver's room must be physically separated from the waste room. When viewed from the above requirements, of course, using ambulances and public health center as medical waste transporters is not recommended because puskel does not have a barrier between the driver and the waste and is also used to deliver referred patients as well as for public health center officers going to the field as well as ambulances are vehicles used to carry patients, not medical waste.

Proper transportation is an important part of waste management from health care facility activities. External transportation is carried out from the temporary storage of hazardous and toxic waste at the public health center to the collection point (depot). Transportation of Medical Waste from the temporary storage of hazardous and toxic waste at the public health center to the collection point (depot) is carried out by the public health center using motorized vehicles with 2 (two) wheels, 3 (three) wheels, or 4 (four) wheels in accordance with the provisions of laws and regulations. As for the direct transportation

from the temporary storage site of the public health center' hazardous medical waste or from the collection site (depot) to the final treatment site, it is carried out by a licensed unit/business entity or 3rd party using a motorized vehicle with 4 (four) wheels or more. Transportation.

Based on the results of path analysis using the SEM method, it is found that transportation directly affects the management of Public health center hazardous medical waste with a total effect (β) of : 0,590.

In connection with the incompatibility of the transportation process with the specified requirements, especially using puskel or ambulance, it is clear that besides not meeting the requirements, it is also dangerous for patients and officers, so for this reason, the regional government of Solok Regency should provide special vehicles for transporting hazardous medical waste that can reach all public health center in Solok Regency, which are used to transport hazardous medical waste from public health center to depots.

Based on table 1, the statistical test results of path analysis with the SEM method obtained a T-value of 1.733 with a confidence level of 95%. The value of 1.733 < 1.96. This shows that storage has no significant effect on hazardous waste management.

In the overall results, it can be seen that all variables in the path analysis, namely sorting, packaging and transportation, are able to influence hazardous waste management efforts in explaining the variance of each variable by 89.5% and there is a value of 10.5% explained by other factors. And after research and based on theory, other factors that influence hazardous waste management are officer behavior consisting of knowledge, attitudes and actions of officers, the role of cross-sectors, the role of government.

## CONCLUSION

In the overall results, it can be seen that all variables in the path analysis, namely sorting, packaging and transportation, are able to influence hazardous waste management efforts in explaining the variance of each variable by 89.5% and there is a value of 10.5% explained by other factors. Based on the results of path analysis using the SEM method, it is found that sorting directly and indirectly affects the management of hazardous waste at the Public health center with a total effect of : 2,331. The results of the path analysis using the SEM method found that storage indirectly affects the management of hazardous medical waste Public health center waste with a total effect (β) of : 1.896, packaging directly affects the management of hazardous waste health centers with a total effect (β) of : -0.185 and transportation directly affects the management of Public health center hazardous waste with a total effect (β) of : 0,590.

## ETHICAL CLEARANCE

All the ethical issues (plagiarism, informed concent, double publication or submission) have been observed by the authors.

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## CONFLICT OF INTEREST

We declare that there is no conflict of interest

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