

Study of Waste Generation and Composition in the Capital of Dili, Dili Municipality, Timor-Leste

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Abstract. Waste is a global problem most countries in the world always find it during the rainy and dry season. Waste management in Timor-Leste uses a dumping system, where waste from the community is directly disposed to the final waste disposal site without going through a separation and processing. Dili is the capital of Timor-Leste with a total population of 352,553 people. It is the largest city and population compared to other cities in Timor-Leste. With a growing population, of course, in fulfilling daily needs, the waste generated will also be high. The research conducted in the Capital of Dili in 4 (four) Sub-District such as; Cristo Rei, Dom Aleixo, Nain Feto and Vera Cruz. This research aims to determine the generation and composition of waste produced by 4 districts, to identify the role of local government in waste management, to identify the facilities and infrastructure in supporting waste management and the role of the community in contributing to protecting the existing environment. The research method used in this research is descriptive method with a qualitative approach. Retrieval of data through field observations and interviews with related parties. The results of this research are expected to become a reference and input for local governments in integrated waste management. Keywords: waste, dumping system, Dili, local government.

1. Introduction

The problem of urban waste is an environmental problem that has been considered for a long time in every city in the world so that these problems do not endanger the community and the environment. They need to be addressed as seriously as possible. Garbage has always been a part of society because people continuously produce waste for their needs. Economic and socio-cultural improvements, technology that increases in an area will have an impact on increasing the volume of waste in the area (Azkha, 2007) [1]

Waste management in Dili City, Timor-Leste uses a dumping system, namely waste from households, hotels, industries, hospitals, supermarkets, and other places, directly disposed of at the final waste disposal site without going through a separation and processing process [2]. Dili City is the capital city of Timor-Leste, with a total population of 352,553 people. It is the largest city and also the most significant population compared to other cities in Timor-Leste. With this population density, of course, in fulfilling daily needs, the waste produced will also be high (Timor-Leste Statistics Data 2020) [3]. In 2019, every day, the City

Government through the Sanitation Department, have to collect 250 tonnes of waste, about 55% of which is dumped in final shelters, while the remaining 45% of the people in Dili are dumped into rivers, sea, burned and buried (ADB 2013) [4]

The distribution of the increasing population of Timor-Leste, especially in the capital city of Dili, will directly affect the behaviour or lifestyle and consumption patterns of the people themselves. Changes in the community's behaviour, lifestyle, and consumption patterns will also affect the increase in the volume of waste, the characteristics of the increasingly mixed waste, and the increase in the volume of waste [5].

Given the large quantity of waste in urban areas that must be managed, in general, the problem of waste management is a problem faced by every city government [6]. The waste management includes how the system for collecting, transporting and the proper location of landfills. For large and metropolitan cities, the waste management program will become even more severe if it touches on waste disposal location planning, waste processing facilities and infrastructure, unavailability of land in urban areas, community rejection, budget provision and the need for collaboration between stakeholders and between agencies [7].

The implementation of Government policies in waste management in the capital city of Dili began in 2008 with the emergence of regulation from the Ministry of Home Affairs of Timor-Leste by making innovations for environmental management in a planned, measured and sustainable manner by involving all parties involved. The Government has made all kinds of efforts of the City of Dili to change the paradigm of society regarding waste management. One of them is by issuing Timor-Leste Ministry of Home Affairs Regulation No. 33/2008/08 concerning Guidelines for Waste Management [8], which explains that;

- In order to create a healthy and clean environment from waste.
- Waste needs to be handled in a comprehensive and integrated manner from upstream to downstream.
- In the context of handling waste in a comprehensive and integrated manner, it is necessary to involve the participation of the community and the business world proportionally, effectively and efficiently.

Although the Ministry of Home Affairs has established regulations on waste management guidelines, there are still a lot of piles of waste in the corners of the city, both piled up on public roads, city parks, in rivers, on the coast and other places [9].

It is necessary to have supervision, control, and proper utilization of their duties and functions by the Government. The Ministry of Home Affairs is authorized, but other related ministries with the same function must work together to overcome the waste problem [10]. Disseminate and educate the public about the impact of waste management. Suppose the participation of the Government and the community is in the same direction and in managing waste correctly and adequately. In that case, it will have a positive and beneficial impact on health, environment, economy and society [11].

This research aims to determine the generation and composition of waste produced by four districts, identify the role of the Local Government in waste management, identify the facilities and infrastructure in supporting waste management, and the community's role in protecting the existing environment.

2. Research Methodology

This research aims to identify the role of local government in waste management, identify facilities and infrastructure in supporting waste management, and the community's role in contributing to protecting the existing environment. The research method used in this research is the descriptive method with a qualitative approach. They are collecting data through field observations and interviews with related parties. Data taken from 2017 - 2019 is in the form of data from related agencies.

3. Discussion

3.1 Waste Management Technical Aspects

Analysis of waste generation and composition

Table 1. The calculation of daily waste generation in four sub-districts in Dili.

No.	Sub-District	Truck Unit	Year	Daily Load/Truck (Tonns)
1	Cristo Rei	9	2017	2.15
			2018	2.21
			2019	2.23
2	Dom Aleixo	11	2017	1.96
			2018	2
			2019	2.26
3	Nain Feto	9	2017	2.04
			2018	2.21
			2019	2.23
4	Vera Cruz	9	2017	1.74
			2018	2.24
			2019	2.36

The following is an explanation of the table above;

1) Cristo Rei Sub-District

The total operational waste trucks for Cristo Rei Sub-District are seven units. In 2017, trucks transported 2.76 tons of waste to the landfill every day for each garbage truck. Moreover, in 2018, garbage trucks transported garbage collected from each garbage bin in the sub-district and disposed to the landfill by 2.84 tons for each garbage truck. Then in 2019, trucks transporting garbage every day that is disposed to the landfill amounted to 2.87 tons for each garbage truck.

2) Dom Aleixo Sub-District

The total operational transportation waste truck for Dom Aleixo Sub-District is nine units. In 2017, trucks transported 2.15 tons of waste to the landfill every day for each garbage truck. Moreover, in 2018, garbage trucks every day transported garbage collected from each garbage bin in the sub-district and disposed to the landfill by 2.44 tons for each garbage truck. Then in 2019, trucks transporting garbage every day that is disposed to the landfill amounted to 2.76 tons for each garbage truck.

3) Nain Feto Sub-District

The total operational transportation waste truck for Dom Aleixo Sub-District is seven units. In 2017, trucks transported 2.63 tons of waste to the landfill every day for each garbage truck. Moreover, in 2018, garbage trucks transported garbage collected from each garbage bin in the sub-district and disposed to the landfill by 2.84 tons for each garbage truck. Then in 2019, trucks transporting garbage every day that is disposed to the landfill amounted to 2.87 tons for each garbage truck.

4) Vera Cruz Sub-District

The total operational transportation waste truck for Dom Aleixo Sub-District is seven units. In 2017, trucks transported 2.24 tons of waste to the landfill every day for each garbage truck. Moreover, in 2018, garbage trucks every day transported garbage collected from each

garbage bin in the sub-district and disposed to the landfill by 2.88 tons for each garbage truck. Then in 2019, trucks transporting garbage every day that is disposed to the landfill amounted to 3 tons for each garbage truck.

The amount of waste generated is spread over 4 (four) districts in Dili District, Timor-Leste, namely; The districts of Cristo Rei, Dom Aleixo, Nain Feto and Vera Cruz, are described in the following table;

Table 2. The amount of waste generated in 4 Sub-Districts in Dili Capital.

Waste in Cristo Rei Sub-District			
Year	2017	2018	2019
Ammount of waste generation (tonnes/year)	7077	7263	7352
Population ; 55,195			
Waste in Dom Aleixo Sub-District			
Year	2017	2018	2019
Ammount of waste generation (tonnes/year)	7904	8033	9098
Population ; 105,328			
Waste in Nain Feto Sub-District			
Year	2017	2018	2019
Ammount of waste generation (tonnes/year)	6732	7263	7351
Population ; 26,672			
Waste in Vera Cruz Sub-District			
Year	2017	2018	2019
Ammount of waste generation (tonnes/year)	5745	7379	7780
Population ; 43,055			

Source: Sanitary Service of Dili Municipality, Timor-Leste (Saniamento) 2020 [11]

Based on the table above, it is mentioned that;

- o In In the city of Dili, there has been an increase in the amount of waste generation for the last 3 (three) years in Cristo Rei District, namely in 2017 with a total of 7,077 tons, then in 2018 with a total of 7,263 tons and 2019 with a total waste generation of 7,352 tons.
- o In Dom Alexio Sub-district is a sub-district with the largest population of people in Dili District, namely 105,328 people; this will directly impact the amount of waste generated. Based on data from the Dili District Sanitation Service, Timor-Leste (Saniamento), it is known that in 2019 this sub-district became the sub-district with the most significant amount of waste generation in Dili Regency, namely 9,098 tons of waste.
- o Furthermore, the waste generation in Nain Feto District, namely in 2017, amounted to 6,732 tons. The amount of this waste generation increased significantly in 2019 with the amount of 7,351 tons of waste.
- o Moreover, one of the sub-districts in Dili District, one of the 4 (four) districts with the most significant causes of waste generation, is Kecamatan Vera Cruz. Vera Cruz

Sub-district is also one of the largest waste contributor districts in the Dili Regency. The amount of this waste generation continues to increase every year. The amount of this waste generation peaks in 2019 with a total of 7,780 tons of waste.

From four Sub-Districts in Dili Municipality, the waste generation is found in the residential areas, markets, shops and offices; it is known that:

o Residential Area

Based on the author's observations, garbage collection in residential areas appears that waste from housing in 4 sub-districts in Distrito Dili Timor Leste is collected almost every day. Every household throws an-organic waste in trash bins on every street corner. Meanwhile, organic waste such as leftovers from food, vegetables, and fruit skins is also disposed of together in the trash can.

o Market Area

For garbage collection in the market area, the sellers first collect the garbage in plastic bags and then throw the collected garbage into the trash bin located near the market. As for the sellers who only let trash scattered at the selling location and open it in the trash cans that have been provided. Another problem is that the garbage bin does not have a cover so that when blown by the wind, it will be scattered everywhere; some will go into the gutter.

o Office Area

For waste collection in the office area, it is known that it is pretty adequate where almost all office areas have their garbage disposal sites, and the majority of individuals in the office area have the awareness to dispose of waste in its place.

o Shop Matters

Every store mainly produces paper waste from cardboard and other products. The shop sellers throw the resulting waste directly into the trash bins near the shopping area.

The composition of waste types

Table 3. The composition of waste types in Dili Municipality.

No.	Waste Component	%
1	Organic	98,19
2	Plastic	0,58
3	Paper	0,58
4	Metal	0,11
5	Rubber	0,08
6	Fabric	0,03
7	Glass	0,02
8	Others	0,41
Total		100

Source: Sanitary Service of Dili Municipality, Timor-Leste (Saniamento) 2020 [11]

Waste management infrastructure and facilities

1. Containerization

The container system in Dili is the producer of waste, disposing of the waste directly in the place that the Regional Government has prepared in the form of waste bins totalling 335 units of waste bins in every corner of Dili. There is no sorting system that is applied in every household.

2. Collection

The waste collection stage in Dili is carried out at a temporary disposal site by a waste generator on the side of a large road. The facilities carried out at this waste collection stage are in the form of a waste truck.

3. Transportation

The means of transportation used in transporting waste are 8 (eight) trucks from the City Government and hiring 30 private trucks, a total of 38 trucks for transporting waste in Dili. The current condition is that every time you transport waste, you never use a cover, there is no leachate protection, and the workforce carrying waste is also very minimal. The carrying capacity of waste in the city of Dili in 2019 based on data from the Dili District Sanitation Office is shown in the table below.

Table 4. The volume carried (m³).

No.	Month	Load		No.	Month	Load
1	January	2599		7	July	2626
2	February	2583		8	August	2637
3	March	2589		9	September	2685
4	April	2605		10	October	2588
5	May	2608		11	November	2706
6	June	2606		12	December	2749
Total		31,581 (53,52 %)				

Source: Sanitary Service of Dili Municipality, Timor-Leste (Saniamento) 2020 [11]

In the table above, it is known that the amount of waste transportation in the city of Dili in 2019 is still low and has not reached the Government's target of 98%; the amount of waste transported only reaches 53.52%, while the remaining 46.48% of waste is not transported. This phenomenon has become a significant problem in Dili District, even since this policy was initiated and implemented in 2008.

4. Final disposal

The location of the final waste disposal is waste disposed of in other districts with TPA because there is no land in the city of Dili for waste disposal. The waste disposed of at the TPA is only burned without paying attention to the leachate and smoke treatment from burning the waste. Often it is bad for the health of the people living around the landfill due to smoke and leachate from waste.

3.2 Non-Technical Aspects of Waste Management

Laws and Regulation

The regulation implemented in the city of Dili is the Regulation of the Ministry of Home Affairs of Timor-Leste No. 33/2008/08 concerning Guidelines for Waste Management. The importance of this policy is to influence community behaviour patterns and provide arrangements for the community to be more orderly in disposing of waste because the community is the producer of the waste itself. The government has prepared trash bins and what is needed is the awareness of the community itself to protect the environment by disposing of garbage in its place. It is hoped that this policy can influence the behaviour patterns of the community so that they are more aware of managing the waste produced.

3.3 Community Participation

The level of community participation in waste management carried out [13], namely;

- The minimum participation of each household that every house in the settlement is not separated from waste before it is disposed of in the trash.
- Lack of public awareness of waste management.
- There is no waste retribution in Timor-Leste.

4. Conclusion

The current condition of waste management in Dili is still far from ideal in terms of service, packaging, transportation, final processing and management.

The regulations implemented by the Government have not been optimal so that there is still a gap for the community to violate the applicable regulations; around 45% of the people in Dili still throw garbage into the river, sea, burnt and buried. So, it can have an impact on the environment because it is not managed appropriately and adequately.

It is necessary to find the most effective waste management solution; there needs to be cooperation between related agencies, in this case, the Ministry of Administration and State, the Ministry of Health and the State Secretary for Environmental Affairs, it cannot be partial but must be with an integrated system approach and the support of all related parties.

Success in waste management depends on technical, institutional and law enforcement aspects, but the Government also needs to implement financing aspects such as waste retribution.

Community participation in management is essential with the principle that to reduce waste must come from our own will.

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