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Submission date: 31-Mar-2021 12:47PM (UTC+0700)
Submission ID: 1547047778
File name: Management_Design_in_National_Institute_of_Technology_Malang.pdf (614.08K)
Word count: 2580
Character count: 14387

International Journal of Scientific Engineering and Science
Volume 4, Issue 10, pp. 27-31, 2020. ISSN (Online): 2456-7361

Waste Management Design in National Institute of Technology Malang

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Abstract— *University is one of the places with high potential of producing urban waste. Malang National Institute of Technology (ITN) as an educational institution is demanded to be able create ideal conditions both as a place for the educational process and as part of social and environmental entities. The waste generated comes from the activities of the academic community. The composition of waste produced is organic waste and inorganic waste. According to Law Number 18 Year 2008 regarding Waste Management it is explained that there are two main activities namely waste reduction and waste management. Whereas in waste handling activities are activities that begin with sorting in the form of grouping and separation of waste according to the type, amount and nature of waste. The purpose of this research is to analyze the existing condition of waste management in ITN Malang, so that an appropriate picture is obtained to plan the waste management design. The waste management operational technique based on SNI 1924-2454-2002 is sorting, storing and processing waste generation at the source. For the method of measuring the amount of waste generation, the composition and volume of waste is guided by SNI 19-3694-1994 while the projected solid waste generation in the next 10 years is based on the projection of the number of academic communities calculated by the Arithmetic, Geometric and Least Square methods. The projected solid waste generation in 2029 is 1460.48 liters / day or 1.46 m^3 / day. The projection is planned to design an integrated waste treatment building. Calculation results obtained the required land area is 50.5 m^2 with the economic benefit value obtained is Rp. 62,366,220 per year.*

Keywords— *Waste composition and generation, integrated waste management.*

I. INTRODUCTION

University is one of the places with high potential of producing urban waste. Activities of the academic community produce residues in the form of waste. The increase in the number of the academic community can increase the amount of waste and is not balanced with the right solution. So that problems caused by waste become problems and must be resolved.

Undang–undang 18 of 2008 Section 13 re Waste Management. Residential areas, commercial areas, industrial areas, special areas, public facilities, social facilities, and other facilities required to provide waste management facility.

When waste not to managed properly will cause various problems, such as environmental pollution, its causes and carriers of the disease and a decrease in environmental ethics. However, if managed properly, waste also has economic benefits. Therefore it is necessary to plan a solid waste management design that is effective and efficient to implement on National Institute of Technology (ITN) Malang (Campus 1) by approach the institutional, technical, operational, financing and the role of the academic community.

II. LITERATURE REVIEW

Undang–undang 18 of 2008, explains waste that human daily activities and/or natural processes in the solid form. Based on the type, solid waste can be classified as organic and inorganic waste. While based on the origin of solid waste can be grouped as follows namely residential garbage, trash farming and gardening, trash rest of the building and construction of buildings, trash trade and offices as well as industrial waste. (Suprihatin dkk, 1999).

Waste collection system is handling activities that not only collects waste from the container or from container individual and communal but also to transport it to the place certain terminals, either with the transport directly or indirectly (Indonesian National Standard 19-2454-2002). The collection can be done with the collection of each source of waste to be transported to the temporary disposal site (TPS) or directly to the place of final processing (TPA) without going through the transfer process first.

In implementing waste management, a budget is required which includes investment, operation and maintenance costs, management and development costs (Vesilind, Worrell, dan Reinhart, 2002). Waste management that costs money can also provide economic benefits. Waste has a high value if it is managed properly. To get the selling value or price of waste in the open market, then sorting the waste must be done at the beginning. Sorting of waste is made up of trash food / organic waste that can be recycled. Then organic waste will be processed by composting and recyclable waste will be sold, in order to obtain the price of waste as (Krishna et al., 2013).

III. METHOD

The location of this research is ITN campus 1, Bendungan Sigura-gura street Number 2, Lowokwaru, Sumbersari, Malang, East Java Indonesia. With the planning stages of the design as follows:

1. *Data Collection*

The data used in this study are primary data and secondary data. Primary data obtained by observation. While the secondary data is a complement to primary data obtained from relevant agencies through interview, observation, questionnaire and a combination of all them.

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Volume 4, Issue 10, pp. 27-31, 2020. ISSN (Online): 2456-7361

2. *Waste Characteristics Determination Method.*

The determination of this method is based on Indonesian National Standard 19-3964-1994 concerning Collection and Measurement Methods, examples of urban solid waste generation and composition. The purpose of this method is to obtain waste generation and waste management.

3. *Data Analysis*

Based on the research that has been carried out, data will be obtained both primary and secondary data. The data obtained were then analyzed qualitatively and quantitatively. Furthermore, the data that has been collected is processed and analyzed. This stage describes the analysis carried out as the basis for planning the waste management design with an activity of collection, sorting, reuse, recycling, processing and processing aimed at reducing the volume of waste. (UU No. 18 of 2008 re Waste Management).

4. *Waste Management Design*

Waste management design consists of calculating volume and generation of waste and making a waste management design in terms of operational financing, engineering, institutional, legal and regulatory aspects as well as the role of civitas academic.

5. *Integrated Waste Management System Technical Planning*

Three important elements (people, products and processes) as a integration key aspects (Laksmana, 2019). In planning the container design, the capacity of the container is calculated according to the volume of waste produced by civitas academic. Containment design planning distinguishes the type of waste to be sorted and managed, and create integrated waste processing building plans include planning needs of land area, the number of workers and Budget Plan Costs. It also calculated the value of the economic benefits of waste. Where the sales of waste are the results obtained from the sale of plastic waste, paper waste and sales of compost. The amount of profit obtained from the sale of waste is calculated by formula as follows:

- Waste generation A = waste generation a day x % waste composition
- Waste generation salable = waste generation A x recovery waste factor A
- Sales Results waste = waste generation salable A x sales Results waste A (Waste Bank)
- Projected annual sales revenue waste = results of sales of waste a month x 12 month.

6. *Non-Technical of Waste Management Systems*

Institutional Legal Aspects

In an integrated waste management system, a work unit is required to manage and monitor the system so that it can run, well as planners, implementers and as an evaluator. On integrated waste management on ITN Malang Campus It is necessary to design rules for implementing the system as well. Institutional includes two important aspects, namely the rules and organization. Then that becomes the focus of institutional arrangement is applicable legislation, technical policy institutions to the implementation aspects at the field level, using secondary data.

IV. Results and Discussion

Waste Identification of ITN Malang Campus 1

Based on the research that has been done by Irianti Mei (2019), source of waste from ITN Malang Campus 1 comes from the activities of civitas academic, canteens, laboratories and road waste. The source of waste comes from buildings, institutions and rectorates, Environmental Engineering Buildings, Architectural Engineering buildings, Civil Engineering buildings, Geodesy Engineering buildings, Regional and City Planning buildings, Postgraduate Buildings, Libraries, Canteen A, Canteen B, Parks/Roads. The types of waste generated are organic and inorganic waste including food scraps, garden waste, plastics, paper, diapers, glass, rubber, tissue, styrofoam, wood, and others.

Waste Generation

Waste generation results according to building capacity are presented in the following table:

TABLE 1. Waste Generation Based Building Capacity

No	Source of Waste	Weight Generation of Waste (Kg/hari)	Volume Generation of Waste (m^3/hari)	Density Generation of Waste (Kg/m^3)
1.	Gedung Biro Lembaga dan Rektorat	9,65	3,1075	89,76
2.	Gedung T. Lingkungan	5,05	1,48	50,5
3.	Gedung Perencanaan Wilayah Kota	7,6	1,0975	77,94
4.	Gedung T. Sipil	8,55	1,1075	79,53
5.	Gedung Arsitektur	7,75	2,0975	79,48
6.	Gedung T. Geodesi	6,85	1,11	68,5
7.	Pasca Sarjana	5,6	1,0925	60,54
8.	Perpustakaan	12,65	1,1175	107,65
9.	Kantin	20,18	1,2175	185,48
10.	Taman/Jalan	16,55	1,1225	135,1
	Total	101,29	14,65	69,38
	Average	10,12	1,46	

Source: Secondary Data, 2019

Waste Composition and Characteristics of Waste

Waste composition from various sources of waste that sampling of ITN Malang Campus 1 is as follows:

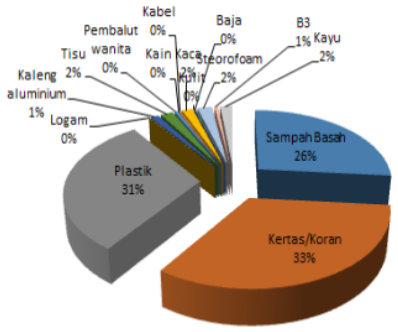

Fig. 1. Composition of Waste Chart

From the graph above, it can be concluded that the percentage of paper/newspaper waste is 33%, plastic waste is

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31% and wet waste is 26%.

The physical characteristics of waste are specific weight. The density of waste specific weight from various waste sources is described in the following graph:

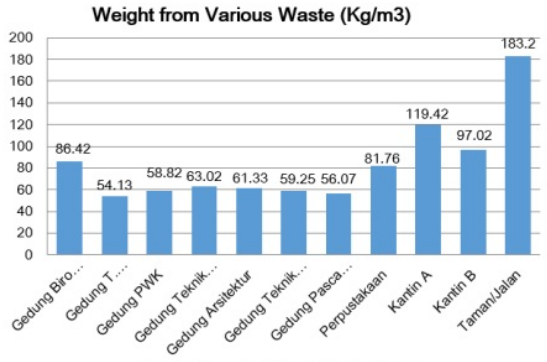

Fig. 2. Characteristics of Waste Graph

Waste Material Balance

Waste Material Balance based on waste generation and composition of waste in ITN Malang Campus 1 area so that the amount of waste that will be included is reduced by processing and recycling and the amount of waste that becomes a reduction for disposal to the TPA.

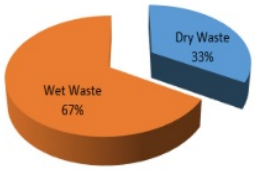

Fig. 3. Wet Waste Composition Average Diagram VS Dry Waste

Existing Condition Waste Management

The existing waste management design of ITN Malang Campus 1 is as follows:

Fig. 4. Existing Waste Management

From Figure 4, it can be seen that the existing waste management model still applies a waste management pattern that is oriented towards collecting, transporting and disposing of waste to the TPA. The current management model does not refer to applicable legislation, namely according to Undang-undang Number 18 of 2008 re Waste Management and also Government Regulation Number 81 of 2012 re Management of Household and Allied Household Waste.

Waste Management Design Analysis

To create a waste management design that is in accordance with the Government Regulation that waste management is a systematic, comprehensive and sustainable activity which includes waste reduction and handling, what we must do is evaluate the current management system.

Receptacle System

The proposed improvements receptacle system of ITN Malang Campus 1 is as follows:

No	Event	Eksisting	Proposed
1.	Receptacle in each room	Receptacle without sorting 	Receptacle with sorting 
2.	Receptacle in every area outside the building and main road	Receptacle without sorting 	Receptacle with sorting 

Source: Research Data, 2020

Fig. 5. Proposed Improvements Receptacle System

Reduction and Handling Waste System

The collection receptacle system planned for waste collection is a pull/push cart. The following is a picture showing the proposed types of waste collection carts and waste collectors.

No	Eksisting	Proposed
1.	Collection carts without sorting 	Collection carts with sorting 
2.		

Fig. 6. Proposed Types of Waste Collection Carts and Waste Collectors

Waste Management Design

1. *Projections of Academic Community and Waste Generation in ITN Malang Campus 1*

The calculation of the projected number of academicians is

International Journal of Scientific Engineering and Science
Volume 4, Issue 10, pp. 27-31, 2020. ISSN (Online): 2456-7361

based on the number of civitas academic in the last 5 years. The number of civitas academic in the last 5 years is as follows:

TABLE 2. Correlation Coefficient with Least Square Method

No	Years	Total Civitas (person)	X	Y	X^2	Y^2	XY
1	2015	2569	1	2569	1	6.599.761	2569
2	2016	2550	2	2550	4	6.502.500	5100
3	2017	2557	3	2557	9	6.538.249	7671
4	2018	2576	4	2576	16	6.635.776	10.304
5	2019	2582	5	2582	25	6.666.724	12.910
Total		12.834	15	12.834	55	32.943.010	38.554

Source: Calculation Results, 2020

Based on the calculation of the correlation coefficient value that has been analyzed, it is close to number 1, namely the calculation using the geometric method. The projection for the number of civitas academic in the next 10 years is as follows:

TABLE 3. Projected Number of Civitas Academic 2020 - 2029

No	Years	Projected Total Civitas (person)
1	2020	2585
2	2021	2587
3	2022	2590
4	2023	2592
5	2024	2595
6	2025	2598
7	2026	2600
8	2027	2603
9	2028	2606
10	2029	2608

Source: Calculation Results, 2020

From the results of the calculation of waste generation sampling, it is possible to estimate the amount of waste generation in 2020-2029 with the calculations in the table as follows:

TABLE 4. Projected Waste Generation 2020 – 2029

No	Years	Total Civitas Projected (person)	Volume of Waste Generation		
			Waste Generation Average	Total of Waste Generation	
			(Liter/person/day)	(Liter/day)	(M^3/day)
1	2020	2585	0,56	1447,38	1,45
2	2021	2587	0,56	1448,84	1,45
3	2022	2590	0,56	1450,30	1,45
4	2023	2592	0,56	1451,77	1,45
5	2024	2595	0,56	1453,23	1,45
6	2025	2598	0,56	1454,70	1,45
7	2026	2600	0,56	1456,17	1,46
8	2027	2603	0,56	1457,64	1,46
9	2028	2606	0,56	1459,11	1,46
10	2029	2608	0,56	1460,58	1,46

Source: Calculation Results, 2020

Based on the calculation of waste generation projections, the percentage of waste management services can be planned. The percentage level of waste management that will be planned can be seen from the state of an area and the amount of waste generated.

2. Integrated Waste Management Site Planning Unit (TPST)

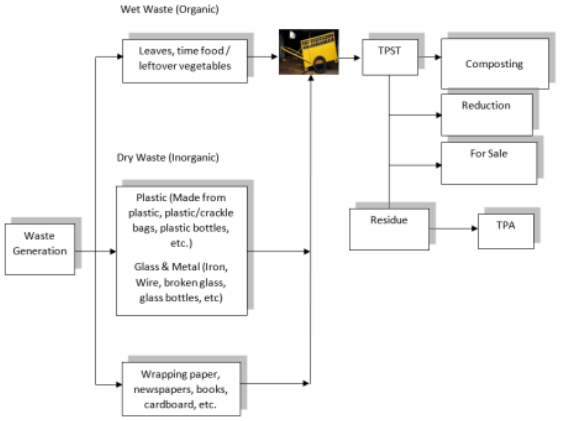

Fig. 7. Projected Waste Management Design Flow

Based on the flow of the waste management design in the Integrated Waste Processing Site area (TPST) there are activities Reuse, Reduce, Recycle. Projected TPST, attention to the potential for existing waste. The components in waste management in integrated waste processing facilities (TPST) in ITN Malang Campus 1 can be explained in the following site plan:

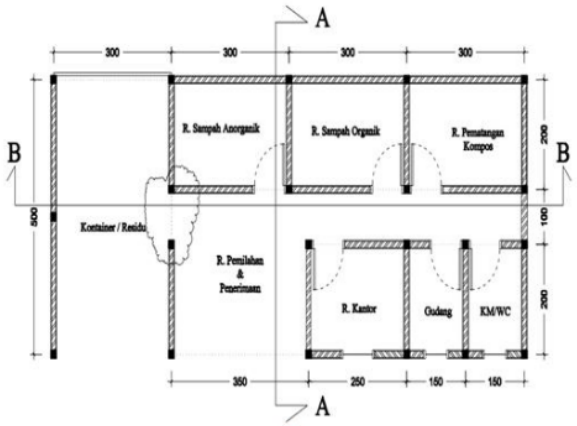

Fig. 8. Site Plan

3. Location Planning

The location of the TPST planning is on ITN Malang campus 1 Bendungan Sigura-gura street Number 2 Malang. It is planned to be in the back of the campus near the exit. The location selection is based on the ease of access for waste trucks to collect residual waste and the limited availability of land. The planning location is presented in the following figure:

Fig. 9. Planning Location TPST

4. *Economic Benefit Value of Waste*

Waste that is managed properly will provide economic benefits and increase income for ITN Malang. The economic benefits obtained are described in the following table:

TABLE 5. Economic Benefit Value of Waste.

No	Types of Waste Sold (a day)	Waste Weight (Kg)	Selling Price (a Kg)	Total (Rp)
1	Paper & Carton	6,08	1850	11.248
2	Newspaper	2,72	3350	9.112
3	Magazine	2,40	400	960
4	Book	1,98	1350	2.673
5	Material Board	3,99	950	3.790,5
6	Mixed Paper, etc.	9,98	1200	11.976
7	Plastic HDPE	3,29	2700	8.883
8	Plastic LDPE	3,64	3300	12.012
9	Plastic PET	10,31	6000	61.860
10	Plastic Mix	3,61	2500	9.025
11	Compost	4,17	10.000	41.700
			Total	**173.239,5**

Source: Calculation Results, 2020

From the table above. it can be seen that the economic benefits of waste a day are equal to Rp. 173.239,5. If calculated in one month the economic benefit value of waste is Rp 5.197.185,-. Then it can be calculated that the value of waste utilization in 1 year is equal to Rp. 62.366.200,-.

V. Conclusions

Based on results and discussion from this research, the following conclusions can be follows:

1. Waste handling does not only attention to waste disposal but also requires attention to the packaging, sorting, transportation, management and final waste processing.
2. It is necessary to make a uniform waste sorting container to facilitate the process of sorting waste to TPS.
3. This waste management will run more optimally if the cooperation between civitas academic, including students, lecturers, teaching staff and stakeholders, is well established. Civitas academic can work together in sorting waste, while stakeholders form policies and build adequate infrastructure.

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