Study of waste management towards sustainable green campus in Universitas Gadjah Mada

Mega Setyowati1*, Arif Kusumawanto2 and Agus Prasetya3

1Master Program of Systems Engineering, Faculty of Engineering, Universitas Gadjah Mada
2Architecture and Planning Engineering Department, Faculty of Engineering, Universitas Gadjah Mada
3Department of Chemical Engineering, Faculty of Engineering, Universitas Gadjah Mada

*Corresponding email: mega.setyowati@mail.ugm.ac.id

Abstract. Waste management is a part of the green campus achievement program. Universitas Gadjah Mada has a Standard Operating Procedure for managing produced waste. Waste produced by each building or work unit is temporarily accommodated in the waste depot before dumped into the landfill. This research aims to study the waste management system in UGM, in accordance with the concept of a green campus. The concept of green campus to improve the efficiency of waste management needs to be supported by various parties. The success of the green campus program relies on an integrated approach, a sustainable implementation that involves stakeholders of the university. In actualizing the concept of a green campus, the university has its own waste processing system. The organic produced waste is processed into compost, while plastic waste is converted into alternative fuel. Overall, the waste management system that UGM owns is ineffective and inefficient, it was proved by the fact that there is still much waste dumped into the landfill. UGM provides a laboratory that is specialized to process waste that is produced by UGM. It is planned to be able to reduce the amount of waste that is dumped into the landfill. According to the results, vermicomposting technology, the manufacture of liquid fertilizer from leachate, and the manufacture of the composite from a mixture of leaves and paper were offered as solutions.

1. Introduction

The Green campus is the higher education community to increase energy efficiency, conserve resources and enhance the quality of the environment by educating the sustainability and creating a healthier life and learning environment [1]. The green campus continues to be built was the concept of areas of education that pays attention to environmental issues. Not surprising that the university is currently implementing a number of policies, directed to support the effort to become an environmentally friendly campus [2]. The activities of the University staff and students on campus will generate a lot of waste, therefore some of the programs and the handling of waste should be one of the University's attention.

The university already has Standard Operating Procedures for managing the waste generated in the area of the campus. Waste from sources from the Faculty/Unit of work put into Garbage Containers/Container inside Waste which is not far from the area of the Cluster. The staff of the
Directorate of assets using the truck will take the waste from the appropriate Cluster type for Depo is sent to the laboratory waste recycling (LDUS) located in the center of the Innovation of Agro technology (PIAT) is a locality of Universitas Gadjah Mada in Kalitirto, Berbah, Sleman. The waste has been sent to the LDUS back will be issued in accordance with the type. Organic waste will be processed into Compost so that it would be more beneficial to society and the environment, where the waste residue that cannot be processed will be sent to Landfills in Piyungan [3].

Green campus assessment refers to assessment criteria and standards set by the UI GreenMetric World University Ranking as its base. The criteria used are the recycling programs, toxic waste recycling, organic waste processing, inorganic waste treatment, waste disposal, a policy to reduce the use of paper and plastic on the campus of [4]. GreenMetric a UI can be a framework and guidelines for building Green University standards, and therefore help the universities to Greenwash the whole of their activity. Reflect the results of the ranking, each participating university can test their strengths and weaknesses in promoting green and sustainable University [5].

This research aims to study the system of waste management at the University of Gadjah Mada, in accordance with the concept of a green campus. Waste management is one of the parameters to realize the concept of a green campus. The activity of the processing and recycling of waste is a major factor in creating a sustainable environment.

2. Methods
Research is done in the area of Gadjah Mada University and laboratory waste recycling (LDUS) in Kalitirto, Berbah, Sleman. Research using qualitative and quantitative approaches, where the early stages of the research process in the form of observations or identification of problems surrounding the waste management system in the University. Data collected through interviews with the stakeholders and a review of the literature on waste management and processing systems. The interview was conducted to staff the trash, landscape, and the funeral of the Directorate of assets and staff of the LDUS.

2.1. GreenMetric
The results of the interviews are then given a valuation based on the scoring system issued by the rank GreenMetric a UI. The results of the assessment can be used as a reference in order to realize the concept of a green campus in the waste sector. The activity of the processing and recycling of waste is a major factor in creating a sustainable environment. The activities of the University staff and students on campus will generate a lot of waste, therefore some of the programs and the handling of waste should be one of the University's attention, namely recycling programs, recycling toxic wastes, sewage treatment organic, inorganic, sewage treatment, waste disposal policy to reduce the use of paper and plastic on the campus of [4]. In this study, some of the programs and the handling of waste should be a major concern in the program of recycling, organic waste processing, and inorganic waste processing. Specific indicators and their wastes are given points shown in Table 1 [4].

| No. | Criteria and indicators                                      | Points | Score          |
|-----|-------------------------------------------------------------|--------|----------------|
| WS2 | Recycling program for university waste                      | 300    |                |
|     | None                                                        | 0      | 0              |
|     | Partial (less than 25% of waste)                            | 0.33x300 |                |
|     | Partial (25%-50% of waste)                                 | 0.66x300 |                |
|     | Extensive (more than 50% of waste)                         | 300    |                |
| WS4 | Organic waste treatment                                     | 300    |                |
|     | Open dumping                                                | 0      |                |
|     | Partly composted and compost dumped                         | 0.25x300 |                |
|     | Partly composted and compost used                           | 0.5x300 |                |
3. Result and Discussion

Data used in the study is the "Laporan Survey Sampah Kampus" (UGM) in 2016 and Focus Group Discussion "Menuju UGM Sebagai Pelopor Kampus Swakelola Sampah " PIAT-UGM 2016. Data from the 2016 Garbage Survey Report (Gadjah Mada University) provides information on the generation and composition of garbage in Gadjah Mada University and campus waste management in actual conditions. While the data coming from the Focus Group Discussion "Towards UGM as a pioneer of waste self-management campus" PIAT-UGM 2016 provides information on waste processing that has been implemented in LDUS.

Based on the SOP issued by the Asset Directorate, the waste is sorted by type or compost. Waste discharged into the depots are grouped into four types namely: Organic waste consisting of food scraps and trash from landscaping or tree felling, plastic waste comprising bottles and beverages and plastic wrapping, paper waste consisting of paper and used cardboard boxes, as well as other waste which usually consists of canned drinks, Glass bottles, and so forth. Sorting of waste originating from the source as well as garbage collection at one point or depot would be easier for officers to carry out waste transport. The percentage composition of waste generation in table 2 [6]

Table 2. Percentage Composition of Waste Generation

| Name of depot         | Percentage of Waste Generation (% mass average) |
|-----------------------|-----------------------------------------------|
|                       | Organic | Plastic | Paper | Other   |
| Depo Gelanggang       | 66.39   | 15.69   | 4.73  | 13.18   |
| Depo Kantor pusat     | 68.46   | 11.06   | 9.68  | 10.79   |
| Depo Vokasi           | 61.71   | 18.00   | 14.01 | 6.28    |
| Depo Belimbingsari    | 88.87   | 0.88    | 2.39  | 7.86    |
| Depo Filsafat         | 74.86   | 17.14   | 3.98  | 4.01    |
| Depo Pertanian        | 61.23   | 8.69    | 25.10 | 4.99    |
| Depo Agro             | 52.07   | 7.02    | 21.23 | 19.68   |
| Depo Purnabudaya      | 79.03   | 1.17    | 15.15 | 4.65    |
| Depo Teknik           | 41.53   | 16.23   | 4.96  | 37.27   |
| Depo Biologi          | 70.74   | 3.67    | 1.96  | 23.63   |
| **Average**           | 66.49   | 9.96    | 10.32 | 13.23   |

Based on table 2, organic waste is the most generated waste in UGM with an average percentage of organic waste disposed at each depot is 66.49%. The organic waste collected in the depot consists of garden waste or felling, and food waste from canteens or food courts and buildings. Waste from Depo Biologi and Depo Teknik is waste sent to LDUS to be processed because the waste from both depots is considered to fulfill the criteria of LDUS incoming waste which is 80% of organic waste and 20% of waste is included. In addition to being located in an overgrown area of trees, biological clusters have two depots where one depot operates filled with street sweeps or tree felling, while the technical depot is a depot where the depot is constructed separately between organic waste, Plastics, paper waste, and other garbage. Other garbage consisting of glass waste, iron, cans, and others have the second largest
percentage of 13.23%. While paper waste consisting of used paper lecture and cardboard food wrapper occupy the third position in the percentage that is equal to 10.32%. Plastic waste consisting of the former food wrappers and bottles of drinks is the type of waste with the average percentage of the smallest of 9.96%. Trash that has been sorted and collected at the depot and then transported by truck to LDUS in the PIAT, Berbah Sleman, and landfills in Piyungan. LDUS a waste treatment facility campus with a total area of 2 ha and a capacity of 10 m3. LDUS development goal is to process organic waste from UGM campus and Berbah district community. Table 3 describes the waste management and technology facilities operating in LDUS under existing conditions in managing campus waste in order to achieve the concept of green campus [7].

| Type of waste | Type of Technology | Capacity     | Product    | Process Time |
|---------------|--------------------|--------------|------------|--------------|
| Organic       | Indore heap        | 32 tub x 6 m³| Compost    | 60 days      |
|               | Windrow            |              | Compost    | 45 days      |
| Plastic       | Pyrolysis          | 30 kg/hour   | Fuel oil   |              |
| Other         | Incinerator        | 20 kg/hour   |            |              |

The waste produced in UGM is partly sent to UGM waste processing laboratory known as LDUS and located in PIAT, Kalitirto Berbah Sleman. The technology applied in LDUS as seen in table 3 operates more on organic waste processing technology in accordance with the applicable SOP. Organic waste derived from UGM area is processed into compost using 2 kinds of technology ie compost or indore heap and windrow composting kompos using indore heap method takes 60 days process time, while windrow composting takes 45 days process. Indore heap composting method, the pile of garbage is on a box-shaped cement media with aeration through pipes contained in the waste pile. Reversal with this method is done every two weeks to once a month by workers. Bioactivator used is leachate water from compost while composting with windrow method, compost pile is above bamboo building in the form of equilateral triangle. Giving aeration naturally through the hole contained in the windrow tunnel flow through the density of buildings on each side of the windrow. Reversal during the study was conducted twice for one month. The bioactivator used is propucin. Although the windrow method takes a shorter processing time, but this method has its drawbacks. Lack of windrow method compared with indore heap method is the absence of leachate water treatment out during the composting process takes place. Leachate should be returned to the heap with leachate flow into the container so that the nutrients contained in the leachate water is not wasted [8]. Plastic waste can be recycled into fuel oil using pyrolysis technology. Pyrolysis equipment owned by LDUS has a capacity of 30 kg / hour each time the process. On the pyrolysis process, can produce alternative fuel in the form of oil of 1-2 liters. Recyclable waste is then burned by incineration process with a tool capacity of 20 kg / h at a temperature of 1000 C. Unrecycleable waste combustion processes are preferred for waste to be sent to the Piyungan final disposal site can be reduced [7]. In table 4 presented the results of the assessment of campus waste management system on the existing condition.
### Table 4. Results of The Assessment of Campus Waste Management System on The Existing Condition

| No. | Criteria and indicators | Score GreenMetric | UGM Points |
|-----|-------------------------|-------------------|------------|
|     | Waste (WS)              |                   |            |
|     | Recycling program for university waste |                   |            |
| WS2 | None                    | 0                 | 99         |
|     | Partial (less than 25% of waste) | 0.33x300           |            |
|     | Partial (25%-50% of waste) | 0.66x300           |            |
|     | Extensive (more than 50% of waste) | 300               |            |
|     | Organic waste treatment |                   |            |
| WS4 | Open dumping            | 0                 |            |
|     | Partly composted and compost dumped | 0.25x300           |            |
|     | Partly composted and compost used | 0.5x300           | 150        |
|     | Fully composted, compost used | 0.75x300           |            |
|     | Fully composted, compost used internally and externally | 300               |            |
|     | Inorganic waste treatment |                   |            |
| WS5 | Burned in open area     | 0                 |            |
|     | Taken off campus to a dump site | 0.33x300           |            |
|     | Partially recycled (less than 50%) | 0.66x300           | 198        |
|     | Fully recycled (more than 50%) | 300               |            |
|     | Total                   | 1200              | 447        |

In Table 4, the total value of the three specific indicators of waste UI GreenMetric ranking was 447 out of a maximum score of 900 [4]. Universitas Gadjah Mad has implemented an integrated waste management system, where waste generated has had a treatment site.

Waste generation produced in UGM is not all can be processed in LDUS. Waste sent to LDUS is sewage coming from the depot biology and engineering depot. Based on the waste generation data in table 3, the average amount of waste generation that can be processed in LDUS is about 16% of the total waste. This is the reason for the assessment of indicators Recycling program for university waste has score 99. The waste that can be processed in LDUS is mostly organic waste that is recycled into compost in accordance with the SOP of waste management [3]. Organic waste will be recycled into compost process. The process of recycling organic waste into compost in LDUS using two methods namely Indore heap method and windrow method. Indicator Organic waste treatment on scoring system UI GreenMetric ranking has 150 points with the reason that organic waste produced in UGM area especially leaf waste has been processed into compost in LDUS and the compost product produced is used as fertilizer for plants in UGM and PIAT areas. The inorganic waste produced in UGM area can be through pyrolysis and incineration process to reduce waste disposal to Piyungan disposal site. UI GreenMetric rating indicator Inorganic waste treatment rate has a score of 198 because the inorganic waste generated has been recycled in LDUS even though only a small part. Plastic waste can be recycled into fuel oil through pyrolysis process. Meanwhile, other inorganic waste (especially waste included from biological depots and engineering depots) can be through incineration process. The fuel oil produced in the pyrolysis process can be used as fuel in the incineration process.

Waste processing technology at UGM needs to be improved in order to meet the indicators issued by UI GreenMetric ranking. To meet the criteria and indicators Recycling program for university waste to be effective and efficient, waste produced at least 50% processed. Universities can enact regulations on waste recycling programs starting from the source. In addition to promoting waste recycling programs, universities may encourage academicians to reduce the use of potentially wasteful waste materials such as reducing paper use in lectures, bringing drinking or reusable feeding, and so
on. The organic waste generated especially the garden garbage and road sweep can be processed into compost in LDUS. Composting technology that has been run on LDUS can be added using vermicomposting technology that requires faster processing time than indore heap and windrow method that is 30 days [9]. The process of recycling organic waste in composting with indore heap and windrow method using leaves as raw materials. While the vermicomposting method can use the waste of food that comes from canteen, building, and foodcourt. The vermicomposting process has faster compost harvesting time than the other two methods of 30 days. The utilization of food waste can reduce the amount of waste disposal to Piyungan's final dump. And the compost produced from the vermicomposting method can be used for plant fertilizer around the canteen or leach foodcourt resulting from the composting process can be used as liquid fertilizer. With the method of composting with worms or vermicomposting where the process time is faster, it is expected that all organic waste can be processed so that the criteria in organic waste treatment can be maximized (Fully composted, compost used internally and externally) and the compost can be used in the region. The resulting leaf litter can be mixed with paper waste to become composite. Paper waste can be used as raw material for recycled paper or mixed as a composite material together with the leaf litter with a paper waste composition ratio of 60% by weight and leaves 40% [10]. Paper waste in the form of cardboard also can be processed into recycled paper. Other waste that cannot be processed can be burned in the incinerator to reduce waste disposal to the final disposal of piyungan. Incinerator installations require relatively little land when compared to landfills and composting and can operate continuously. The process of recycling inorganic waste such as waste plastic, waste paper, and other debris can increase the score in the ranking GreenMetric UI indicator becomes maximum scores and also can reduce the amount of waste in landfills Piyungan. Additional methods of waste processing can improve score indicator on UI GreenMetric ranking because 50% of waste generated in UGM area can be recycled. In addition, waste generated will increase in trash in the area of the campus there is an activity involving many people. to reduce the rate of waste dumped into the depo, University can provide mandatory regulations are adhered to by the event organizers. the given rule can be done before the event takes place by way of doing the mapping timbulan rubbish, at the time the event took place with, and while the event was taking place.

4. Conclusion

The waste management system at UGM is an integrated waste management system. Academic community as a source of waste sorting waste according to the type of organic waste, plastic waste, paper waste, and other garbage. In order to meet the parameters of green campus concept that is the effectiveness of waste management, UGM has processed waste generation. Waste processing is done in LDUS PIAT UGM Kalitirto Area Berbah Sleman District. Assessment of the effectiveness of the application of green campus concept using UI GreenMetric ranking system. The indicator used in this research is Recycling program for the waste university, Organic waste treatment, and Inorganic waste treatment. In LDUS, organic waste is recycled into compost, plastic waste is recycled into alternative fuel oil through pyrolysis processes, and another untreated waste is incinerated. In the existing condition, the total score earned on the three indicators used amounted to 447 of the total maximum value of 900, so that the score on every indicator is maximal, additional technology is needed to recycle the waste generated. Organic waste that dominates the type of waste at UGM can apply the vermicomposting method in composting. The composting method with Indore heap and windrow uses leaf litter as raw material for composting, while in the vermicomposting method it can use the waste of food from canteens, buildings, and food court. Plastic waste generated in UGM area other than recycled into fuel oil can be used as handicraft materials by establishing cooperation with the parties component. Other waste that can not be recycled can be burned through the incineration process so as to reduce the amount of waste disposal to the Piyungan final disposal site. With additional waste treatment alternatives, the GreenMetric UI indicator score can be scaled up to the maximum score.
5. References

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