Innovation of a composter to treat a domestic waste

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Abstract. Waste treatment is very important practise in a country which have high population number, such as Indonesia. Otherwise, there will be overwhelming garbage, which possibly leads to environmental and health problems. However, many people in society still have a low awareness of waste management. The complexity of managing waste is still considered not comparable to the benefits obtained. Therefore, it is necessary to offer the alternative on waste management technologies that are environmentally friendly and in accordance with the needs and economic capabilities of the community. **Aims**: to develop a Composter to treat a household waste in effective and safe for the community. **Methods**: This research develops products by making prototypes. Experimental design was used on this research that began with laboratory tests for product and functions feasibility. An environmental health risk analysis was carried out to ensure that the product was safe for public health. **Results**: We produced a portable Composter for using in household level. This product passed the feasibility test, function feasibility test, and environmental health risks measurement. **Conclusions**: A household scale portable garbage bin be able to function as a composter tank and the environmental health risks was remains acceptable when the tool was operated.

1 Introduction

Based on a survey from the Ministry of Environment and Forestry Republic of Indonesia in 2018, household solid waste was the biggest waste generator (44.5%) of total solid waste in Indonesia. On the other hand, the household solid waste composition was dominated by organismic waste (58%), plastic (14%), paper (9), metal (2%), and other (17%). Therefore, organic solid waste is a potential resource for composting organic waste that can be recycled, and afterward, it is expected to reduce disposal at landfill. Indonesia stands for the fourth rank population in the world [1], requires good waste management to prevent overwhelming waste. Currently, the Indonesian government stands as a regulator in waste management. It is mostly performed through old collect-dump-mechanism known as the *end of the pipe*, i.e., garbage was collected, transported, and dumped into the final landfill [2].

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Waste is a global issue. If not properly dealt with, waste threatens public health and the environment. It is a growing issue linked directly to how society produces and consumes, and it concerns everyone. Waste is an important by-product of human activities that is mostly thrown away because they are considered useless [3].

Because the large amount of organic waste in the environment has become one of the main global problems. Among the various treatments in the management of organic waste such as the use of landfills and incineration, the decomposition of organic waste through the use of biological processes is considered a more appropriate method of solution. Composting is one of the low-cost biological decomposition processes. The composting process is circuited by microbial activity [4].

The global waste crisis, exacerbated by unsustainable consumption patterns and inadequate waste management infrastructure, poses a significant threat to environmental health and social well-being. SDG 12: Responsible Consumption and Production emphasizes the need for sustainable consumption and production patterns. Communities, as key stakeholders in waste management, are expected to play an active role in reducing their waste footprint. However, various challenges such as lack of awareness, time constraints, and economic barriers often hinder community participation in waste management initiatives.

Despite the growing concern about waste pollution, many communities remain unaware of the potential benefits of domestic waste treatment. The perceived impracticality and lack of economic incentives often discourage individuals from adopting sustainable waste management practices. To address these challenges and promote SDG 6: Clean Water and Sanitation and SDG 15: Life on Land, it is crucial to develop innovative and accessible waste management solutions that are both environmentally friendly and compatible with community needs. This study aims to design and evaluate a Composter that can effectively treat domestic waste while minimizing environmental health risks.

2 Material and Methods

This research was a study to develop composter products for household waste management. Carrying out product development with prototypes is an important step to realizing user needs in developing products [5]. The research design was carried out as follows Figure 1.

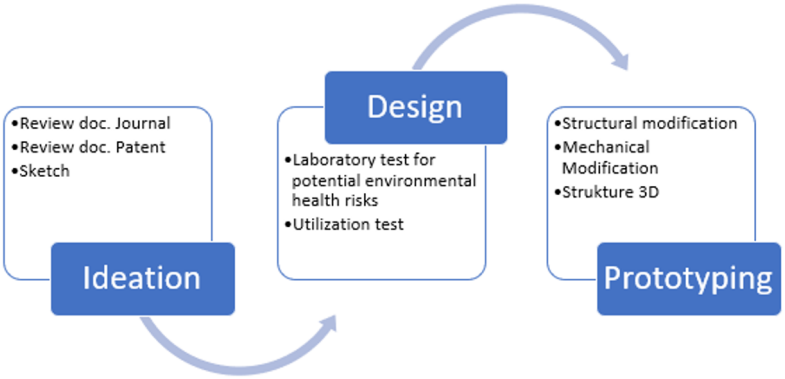

Fig. 1. Prototyping Design

This research was experimental research with laboratory tests to determine the effectiveness of the products was carried out. This research was performed to determine the potential environmental health risks. This is a process that evaluates the likelihood or probability that adverse effects may occur to environmental values, as a result of human

activities. This process is a formal procedure for identifying and estimating the risk of environmental damage.

An assessment is carried out on the risks of using composting tanks. The test was carried out in a home environment. These risks are the risk of diarrhea and disturbance of comfort due to noise when the machine is operated. The risk of diarrheal disease is seen from the density of flies and the risk of noise is measured by sound level maters compared to quality standards.

This study was completed following several steps: Document review was carried out by studying patent documents and previous studies. This stage is carried out to find updates, besides that it is carried out to correct deficiencies in the product design. the design stage is carried out by doing a deep dive into the perception of people's needs for the product, then it is elaborated and arranged specifically, then looking for ideas and being creative. Results Ideas and creations are then analyzed and tested. The test results are used as the basis for prototype development.

The results of the studies carried out are outlined in a detailed concept sketch to capture ideas visually in the form of a product sketch to show an overview of the final product and a technical sketch to show the dimensions of the product, materials, and work. The next stage is transferring the concept sketch to 3D modeling. During the research process, product idea development is carried out to ensure the product can work, there is a model that is detailed enough, looks like the final product, and has the same function.

Effectiveness test aimed to ensure that the product is working. Environmental Health Risks Analysis was performed to assess the potential environmental health risks raises by this product. Product feasibility was tested to determine the feasibility use of the product when it launched. This experiment was conducted in the environmental laboratory of the public health department, Universitas Ahmad Dahlan, Indonesia.

3 Results and Discussion

3.1 Prototipe of Composter

The final product after passing some experiments was a product that meet the purpose of making this tool that is to chopped organic matter in the form of leaves and twigs of 2-3 cm in 5-7 minutes each chopping period. The products were made from several materials as follows: iron plate, iron pipe, iron eser, and grinding dynamo (Figure 2).

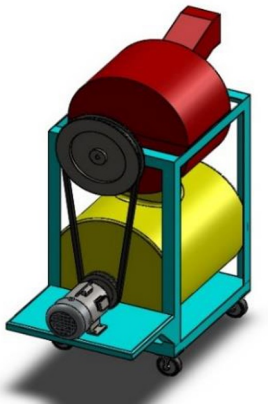

Fig. 2. Composter Products

The parts of the tool were as follows Table 1.

Table 1. Part of the product Composter

No.	Part of the product	Description
1	Chopping room	Attached to the inlet chimney, the top and bottom lid can be opened together with iron hinges
2.	Inlet chimney	Attached to the chopping room, the top part can be opened, and bottom part fused with iron hinges
3	Knife chopper/cutter	Made from stainless steel
4	The connecting room of the chopping room with the storage drum	part to connect the two rooms
5	Shelter drum	There was a stirrer inside from the iron plate and there was an outlet door
6	Stirrer	The lever outside the drum was L-shaped, made of iron plate, center
7	Support legs	as an enforcer
8	Grinding dynamo machine	dynamo machine to drive the grinding
9	Power cable	Located next to the storage drum, it was a door with iron hinges
10	Outlet door	Removing composting results
11	Filter	Filtering the garbage that goes into the drum that has been chopped

The specifications of Table 1 are the last prototype products from several stages of improvements made to the product so that it can operate. The community as a waste producer is expected to also participate in reducing waste generation from the source so that the government's burden decreases as well as environmental health problems, due to waste can be reduced.

To help overcome this problem, we used our knowledge, experience, and skills to create a garbage-processing innovation tool. After a document study and tool design process, we made a new innovative product: a portable organic waste processing bin that was environmentally friendly, inexpensive, and easy. Organic garbage processing bins were often referred to as composters.

A composter is a machine that is used for tearing and converting macro-organic waste products into small or easily biodegradable forms, which can be used as organic fertilizers. Organic waste crushers are designed to be perfect for tearing all types of waste products. Organic waste will be small pieces to be used as manure or organic fertilizer and biogas [6].

The composter was designed by paying attention to the perfect aeration system by considering the adequacy of air circulation to *supply* oxygen for microorganisms in the process of decomposing composted organic matter [7]. During composting, microorganisms degrade organic matter to carbon dioxide, water and ammonia [8]. Composting has great potential to contribute to increasing soil fertility, stabilizing the environment, reducing global warming, improving waste management systems [9], decreased weight and volume of organic waste, recycling of nutrients [10]. Another research likewise stated that composting roled on reduce landfill space, reduce surface and groundwater contamination, reduce methane emissions, reduce transportation costs, reduce air pollution from burning waste, more flexible overall waste management, increase material recycling and can be done with a little capital and operational costs [11].

In the design process, making composter performed several times from the initial plan, and got the final result in the form of a waste processing tool made from the following

materials, including iron plate which was a tool forming body and chopper knife, iron pipe made into drum, iron plate was used as a stirrer iron drum and grinding dynamo which functions to drive the tool. The composter or trash was a portable garbage bin with a household scale where this garbage bin was used to process kitchen waste into compost [7]. The working mechanism of waste processing equipment in the form of garbage bins household scale was designed with a system of chopping, in which the waste materials that have been entered will be chopped with a knife chopper made of iron plates and screened using centrifuges dynamo grinding which can high level spinning so can cut stronger. Then, the garbage will come out in a small size.

Our product was different from the existing composting tool. This tool was a suitable choice for not only environmentally friendly waste disposal, but also for generation quality inputs for organic soil management. High-quality compost produced through this composting method in a short period of time showed potential as an effective technological tool [12]

This garbage processing tool in the form of a household scale garbage bin, was an environmentally friendly tool, has been tested for its environmental and economic feasibility, and continually made improvements so that eventually it was produced a tool that was practical, environmentally friendly, economical, and makes it easier for people to process waste. This innovation, it was expected to solve the problems of the community due to the increasing numbers of garbage.

Based on our search for patent documents, the waste management method designed in this tool was different from the method claimed by UK Patent Application No. Registration of 2494532 in 2013 claimed the method was the composting method. The tool that proposed in this study did not claim to be related to the ideal composting process such as the size of the cut, temperature, and other technicalities, but this tool is claimed about the method of cutting the waste with a chopper and unclaimed size. In the proposed garbage can, not only large-scale waste but household waste such as leftover rice, vegetables, and other household organic waste [13].

Patent Claim No. RU2379134C2 was carried out on devices that can separate household waste between organic and organic and their sorting methods. The difference with the claim of this research was the design of the trash bin that used a garbage sorting system and the mechanism to open the trash so that there was air circulation. The design of the proposed study was that there was a system to open the lid of the garbage so that there was air circulation. Sorting the garbage was done by sorting the waste before it was put into the garbage bin [14].

Patent Claim No. S22201506762 in 2016 was carried out on an automatic waste-based lifting device based on a microcontroller. The test results on a tool called Inntopes can lift waste in the river flow. The use of this tool was more directed at the problem of garbage in the river, while our study aimed at the problem of garbage in the household [15].

In 2017 the Directorate of Patent, DTLST, and RD gave a patent claim under number S00201701208 for the invention of a trash bin that was held in a plastic bag. In addition to using the construction of trash cans, this tool also used plastic bags as its main ingredient. The research proposed was different from this tool because it did not claim the use of plastic bags in garbage cans construction [16].

Patent Claim No. S00201700981 of 2017 was claimed on Portable Digester Shake which can convert organic waste into biogas. This invention is expected to reduce the cost of waste management by converting it to biogas [17]. This is different from our research. This study utilized a garbage bin to convert waste into compost.

3.2 Product feasibility of Composter

Various parameters can be used to monitor composting changes [9]. Physical and biological changes in the composting process depend on temperature, aeration, and humidity, which are directly related to the surface/ volume ratio [18]. Chemical and biochemical changes during composting depend on pH, the ratio of carbon/nitrogen (C/N), respiration enzyme activity, microbial colonies, and bioassay [9]. A test was conducted to determine the feasibility of the product's portable organic waste processing bin to determine the physical and logical changes in the composing process.

The feasibility test of using the composter was carried out on a laboratory scale. The test began by inserting 500 g of compost into the drum collecting. Its function was to activate and reduce moisture and leachate in the drum during the exposure process. Leaf waste per day (for 4 days) 350 gr (to fill the shelter). The results obtained from testing the usefulness of the tool are as follows

Table 2. Laboratory Testing Results in the Environmental Laboratory

No	Component of examination	I		II		III		IV		V		Average
		A	B	A	B	A	B	A	B	A	B	
1	Temperature (degree)	29	27.5	28.5	30	28.5	30.9	29.5	24.7	28	28	28.44
2	Humidity (%)	60.1	68.3	65.7	55.9	69.7	54.1	61.2	74.7	60.7	60.1	63.05

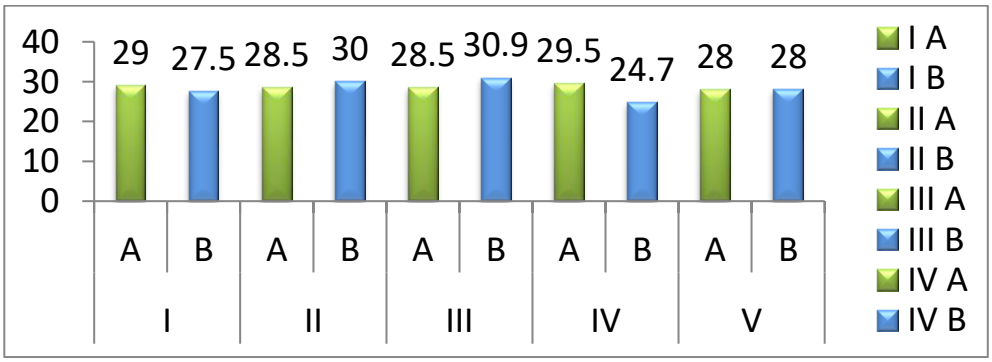

Fig. 1. Temperature Laboratory Testing Result In the environmental laboratory

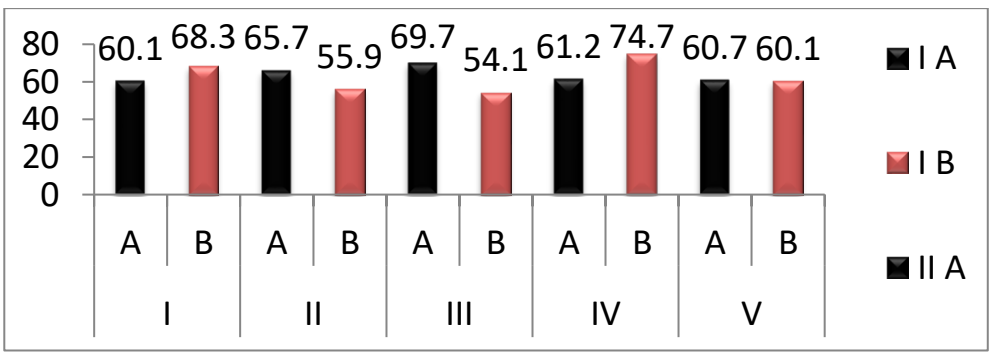

Fig. 2. Humidity Laboratory Testing Result In the environmental laboratory

It was obtained data through this tool the average temperature was 28.44^0 and the average humidity was 63.5 %, this showed that the tool can be used for its composting function. Humidity is an important component of composting [19] . The average humidity obtained from the tool was 63.5 (Table 2). (Tweib et al, 2011) stated that effective composting requires the right ingredients and conditions, including a water content of around 60-70%. This is in line with the results of testing the humidity of this tool. The compost garbage machines help speed composting by increasing the temperature of the compost gradually [9]. With an increase in temperature from room temperature and the humidity levels of over 60%, it indicates the composting process has taken place within the tool and the tool can be used for composting. This test is in line with [20] in Thailand, where the water content is very high, between 60–80%, and the temperature of the compost collection reaches a maximum of more than 55ºC, the experiment shows that the whole system works efficiently in accordance with the design [20].

The public health risks examined in this study are those related to the risk of environmental-based disease due to composting such as diarrheal (from fly vectors) and disturbances in comfort related to the noise produced by the product when operated. The measurement results for 4 days on the first day of treatment are as follows Table 3.

Table 3. Environmental Risks Around the Site of Composter

Observation Parameters	Day 1	Day 2	Day 3	Day 4	Average
Flies density	0	3	1	1	1.25
Noise (dB)	68	105.26	90.1	82.9	86.57

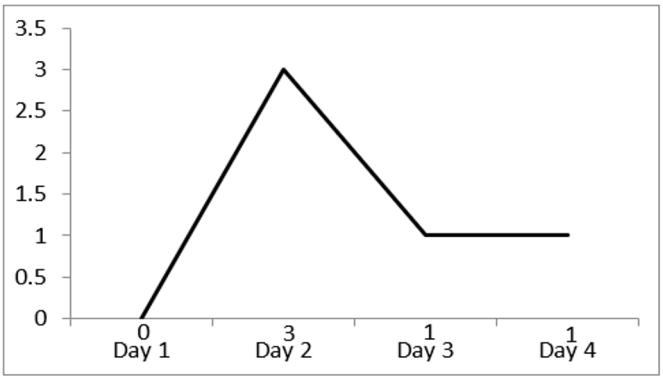

Fig. 4. Flies Density Environmental Risks Around the Site of Composter

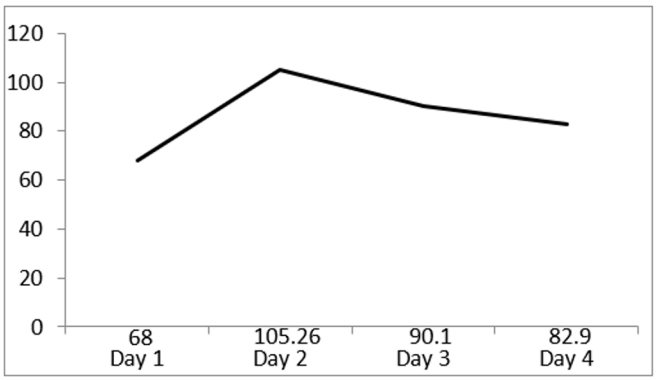

Fig. 5. Noise (dB) Environmental Risks Around the Site of Composter

Table 3 shows that the density of flies around the composting site has an age of 1.25 was still within the limits of the Ministry of Health, which is between 0-2 and includes in the low category or not a problem. Whereas, for moistened, an average value of 86.57 dB exceeds the quality standard threshold for a residential environment with a 55 dB standard.

The environmental health factors studied using this tool were the density of flies. The measurement of fly density is needed for monitoring and controlling assessment. Flies are animals that indicate whether a place has poor sanitation conditions or not. The density of flies can be used as an indicator of whether or not the environment is polluted by organic matter [21]. Flies are one of the living that act as vectors of disease. Flies are said to be disease vectors because it is an organism that carries pathogenic viruses or bacteria and parasites from infected hosts (humans and animals) to other hosts [22] .

Density Measurements Menu for Standard [23] divided is into four categories, 0-2 (head/block grill), not a problem was categorized as low, 3-5 (head/block grill), necessary safeguards against flies breeding sites such as trash, animal waste, and etc.etc.ng in the medium category, 6-20 (tail/grill block), necessary to secure the breeding places of flies and if possible, planned control efforts include high/solid categories, and >20 (tail/grill blocks) necessary to secure the breeding places of flies and flies action control including very high or dense categories.

In the trial of the use of portable bins, it was obtained a level of fly density of 1.25 which, according to the MOH, the density of flies still met healthy environmental standards because it was still below 2 [24]. The flies were still there during the operation of the tool can be caused due to a characteristic of the waste was easy to decompose and caused bad odors, so it attracted the flies [25]. The flies are attracted to bad odors, and the smell of food or drinks that are stimulating, flies are also very interested in foods eaten by humans such as sugar, milk and other foods, human waste, and blood [26]. So, the flies are still found during the operation, but if the composting process goes well, the odor that appears can be minimized so that it does not attract the presence of flies.

Another environmental health factor examined in the use of this tool was the convenience disturbance associated with the noise generated by the product during operation. [27] stated the composting process involved mechanical equipment, physical work, and handling various biological materials. Despite good practices, there will always be risks associated with daily operations, and occasional accidents. However, it can be prevented by the presence of awareness of hazards and readiness to safeguard risks against safety incidents and health problems.

One of the health problems of composting is noise. Noise is a sound that is not desired by the ear [28]. According to the Minister of Manpower of Indonesia stated that noise is all undesirable sounds coming from the means of production processes or tools - a working tool that is at a certain point can cause hearing loss. The composting process tool can be very noisy and potentially only damaging. The hard way does not produce pain, but hearing damage usually occurs gradually, so there is no warning or indication that an injury is occurring [27].

Anticipation efforts are carried out by installing a damper on the part of the device so that it can reduce the noise level. Reducing noise exposure to acceptable levels can be achieved by using engineering controls. A sound damper is a control solution technique be used to reduce noise levels [29]. Besides, the equipment operation is carried out at certain times in the house when the tenants are not doing a lot of activities inside the house or not using tools inside the house but outside the house to reduce the noise caused inside the house.

Another anticipation that can be done is the operation of the equipment must be no more than one hour so that noise disturbances will not result in a health disturbance. The content that can be received by the workforce without causing illness or

health problems in daily work for a time not exceeding 8 hours a day or 40 hours a week is 85 dB(A) [30].

The noise level is 85 dB so as not to cause health problems, it should not exceed 8 hours. With the use of dampers given to motor parts and restrictions on the operation of portable trash bins that do not exceed 8 hours, a day is expected to reduce the disturbance caused by noise. Educational efforts are needed in the operation of this tool so that the process of using the tool can run properly and correctly. This mental health risk analysis study, it becomes an input for improving this tool so that the tool that will be used can meet the standards of waste management and is safe for the surrounding environment that uses this tool later.

4 Conclusion

The prototype of the coma poster is a household scale realized after going through the construction stage of the tool in which there are a series of tests to ensure the tool can operate according to its purpose. The results of the feasibility test of composing the r in the laboratory are that the product can function in accordance, namely for the composter. The test results of environmental health risks due to composter are a low risk for diarrheal diseases but are at risk for disruption in the environment when done in the house environment.

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