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Manufacturing of Organic Waste Shredding Machine

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Abstract

Organic waste is one of the most widely produced types of household and market waste every day. Imoptimal handling causes environmental problems such as bad odors, garbage piles, and increased greenhouse gas emissions. This research aims to design and build a small-scale organic waste shredding machine to help the process of processing waste into compost more efficiently. The design process is carried out with a technical approach including component design using CAD software, material selection, and assembly of the chopping system using an electric motor with a power of 69 kW. Testing is carried out to determine the working capacity and efficiency of the tool. The test results showed that the machine was able to chop various types of organic waste, such as leftover vegetables and leaves, with an average capacity of 63 kg per hour. This machine is designed for the needs of households or small communities, with the advantages of compact dimensions, low energy consumption, and ease of operation and maintenance. This research is expected to support efforts to manage community-based organic waste in a sustainable manner.
Keywords: Shredder, organic waste, design, compost, household scale

1. Introduction

Waste is one of the main problems in environmental management in various countries, including Indonesia. Based on data from the Ministry of Environment and Forestry (MoEF), around 60% of the total waste produced is organic waste [1]. Organic waste comes from food waste, agricultural waste, and other biodegradable materials that if not managed properly can cause environmental pollution, such as bad odors, the spread of diseases, and methane gas (CH_4) emissions that contribute to global warming [2].

To reduce the negative impact of organic waste, a proper treatment system is needed. One of the commonly used methods is **composting**, which is the process of decomposing organic matter by microorganisms to produce organic fertilizers that are beneficial for agriculture [3,4]. However, before organic waste is processed into compost, the raw materials need to be reduced in size so that the decomposition process runs faster and more efficiently[5].

One of the main challenges in organic waste management is its physical characteristics that tend to be wet, non-uniform, and large in size. This condition inhibits the composting process, both naturally and controlled. Therefore, it is necessary to carry out *pre-processing* to reduce the size of waste particles to accelerate decomposition and increase the effectiveness of the advanced treatment process. This is where the role of the chopper becomes very important.

Organic waste shredding machines are designed to speed up the processing process by chopping organic matter into smaller sizes, thereby increasing the surface area of the material and accelerating the biodegradation process [6,7,8]. In addition, this machine also helps reduce the volume of waste so that it is easier to handle and process.

The use of organic waste shredding machines provides several benefits, including, speeding up the composting process by accelerating the decomposition of organic matter, reducing the volume of waste so that it is easier to transport and manage, increasing recycling efficiency, especially in the manufacture of organic fertilizers or animal feed, and reducing the impact of environmental pollution caused by decomposing organic waste in landfills.

In the design of an organic waste

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shredding machine, some factors that need to be considered include, the design of the shredding mechanism, such as a rotary knife system or fixed blade, which affects the effectiveness of shredding [9,10,11], the material and durability of the machine, so that the machine can operate in the long term and withstand different types of organic waste. Energy efficiency, to ensure optimal use of electrical power or fuel. Ease of maintenance and use, so that it can be used by various groups of people, including households and small industries.

The design of an organic waste shredder is the right solution to optimize organic waste management and support zero waste programs and the circular economy. With this machine, it is hoped that it can increase the effectiveness of waste processing, reduce dependence on landfills, and encourage people to care more about the environment.

2. Research Methods

This research method can be seen from the research flow contained in figure 1.

The construction form of the organic waste shredder that will be made is as shown in the following figure 2.

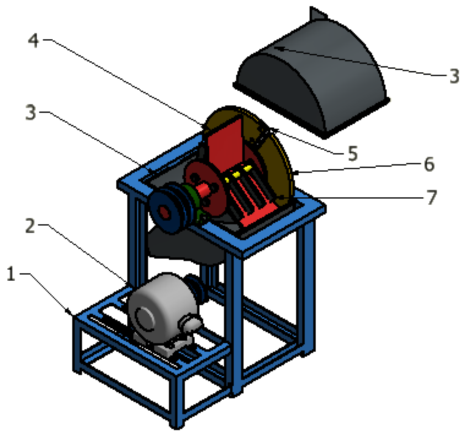


Figure 2. Organic waste shredding machine

Description of organic waste shredding machine:

1. Rangka
2. Electric Motor
3. Casing
4. Fan
5. Pisau
6. Cutting blade holder
7. *Hammer mill*

The way this organic waste shredder works is as follows:

The working principle of this tool is as follows, first the motor is turned on which will load the pulley which will be connected to the *v-belt* and will be received by the pulley and will drive the shaft, *flywhell*, blade, fan and hammer mill. The blade on *the fly whell* will cut through the parts of the litter. It will enter the area *of the blower* being crushed by *the hamermill* and pushed by the fan to the exit because there is a *mess* or filter, then the result can be small parts.

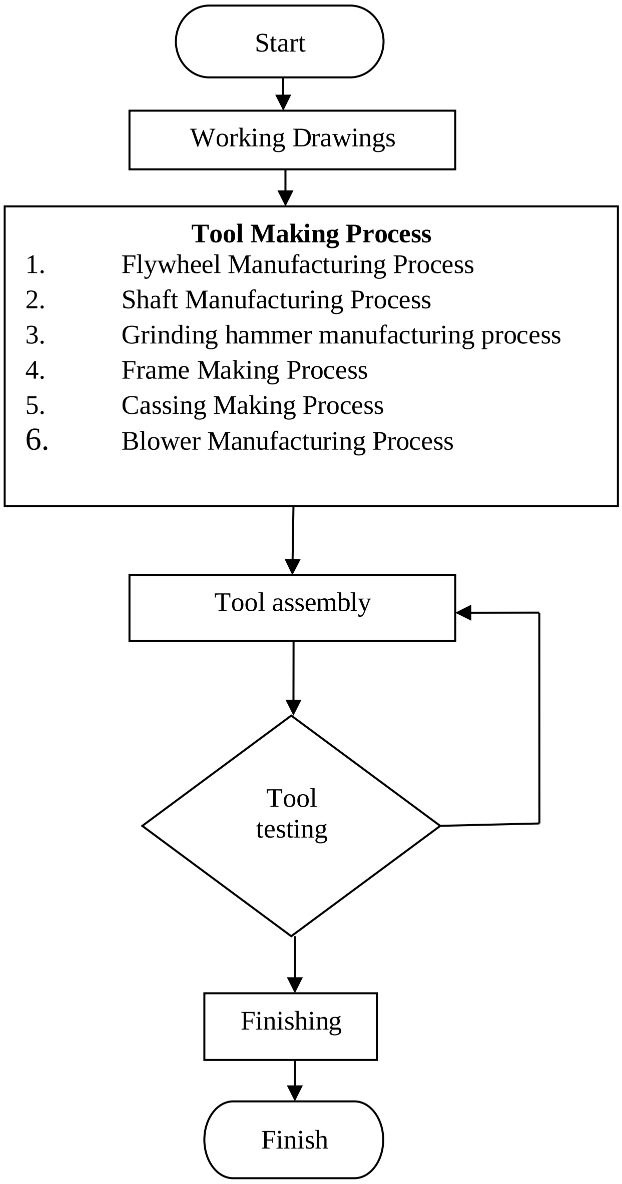


Figure 1. Research Flow Diagram

Table 1. Materials to be designed

No.	Machine Parts	Material	Size
1	Poros	ST 42	$475\ mm \times \emptyset 50.8\ mm$
2	*Fly whell*	ST 37	$\emptyset 400\ mm$
3	*Hammer mill*	ST 42	$200 \times 50 \times 10\ (mm)$
4	Blower	ST 42	$175 \times 160 \times 10\ (mm)$
5	Casing	ST 42	$900 \times 500 \times 1\ (mm)$
6	Rangka	Profile L 4	8 m

Some of the calculations that will be calculated using the formula that will be used in this study can be seen in table 2.

Table 2. Calculation formula

No.	Component	Rumus	Unit
1	Knife Blade Slicing Style	$A = L_{lebar} \times P_{panjang} \times ketajaman\ mata\ pisau\ yg\ diingin$	mm^2
		$T_g = \frac{F}{A}$	kg/mm^2
		T = F x R	Nm
2	Motor Power	$P = \frac{T.2\pi.n}{60}$	watt
3	Belts and pulleys	$\frac{n2}{n1} = \frac{d1}{d2}$	
4	Belt circumference	$L = 2C + \frac{\pi}{2}(d1 + d2) + \frac{1}{4c}(d2 - d1)$	Mm
5	Stake	$F_g = \frac{T}{r}$	N
		$t_g = \frac{f.g}{b.l}$	N/mm^2
		$\sigma = \frac{T}{t1.l.r}$	N/mm^2

3. Results and Discussion

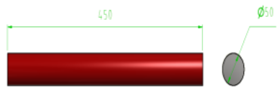
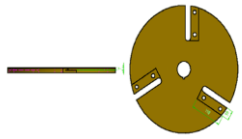
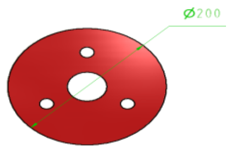
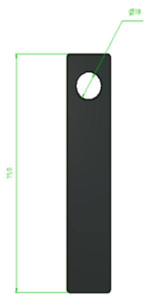
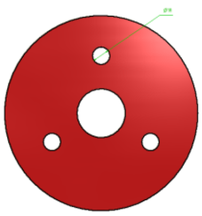
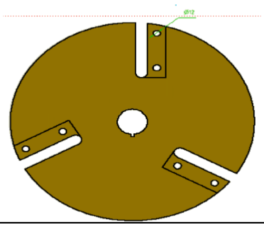
The results obtained from the initial design based on the existing formula, along with the results of the calculations obtained can be seen in table 3.

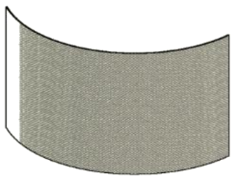
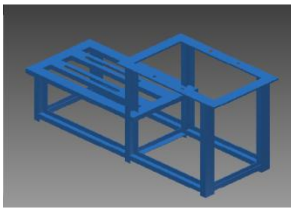
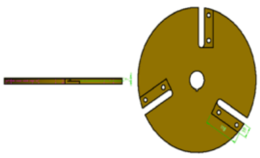
Table 3. Component calculation

No.	Component	Result	Unit
1	Knife blade slicer	12	mm^2
2	Shear tension	1569	N/mm^2
3	Cutter style	18835.2	N
4	Lots of pieces	63	Kg per jam
5	Lap	2100	rpm
6	Torsi	313.92	Nm
7	Daya	69.03	Kw
		12.26	N
		2.511	N/mm^2
8	Pegs and puli	1400	Rpm
		463.38	mm

Based on the results of the calculation, the work on making the machine is carried out as seen in table 4.

Table 4. Manufacturing process

No	Material	Work steps	Picture
1	Main shaft Ø 51 × 450 mm ST 37	Measure the workpiece first and start the work of reducing Ø 51 become Ø 50 Then continue to shorten the 470 workpiece to 450 mm.	
2	Flywhell is turned outside with thickness 18 mm Ø 400 mm ST 37	Measure the workpiece first by cutting the circle using an axcitelin flame then lathe so that it is sized Ø 400 mm	
3	Hummermill Laying Disc Ø 240 ST 37	Measure the workpiece first by cutting the circle using an axcitelin flame then lathe so that it is sized Ø 400 mm	
4	St 42 Sized 30 × 150 hummermill	Read the drawings and make measurements then the part to be drilled is done after that drill	
5	Hummermill Laying Disc Ø 240 ST 37	Read the drawings and make measurements then the part to be drilled is done after that drill	
6	Flywhell in drill withØ 18 Thickness 18 mm Ø 400 mm ST 37	Read the drawings and make measurements then the part to be drilled is done after that drill	

7	Pengeboran mess dengan lebar $^1/_2$ D dengan Ø 10 mm, lebar 275 ST 37	After taking measurements on the workpiece, the worker does a little bit of drilling when the drilling does not miss and makes the work easier if the drilling has been done	
8	Rangka mesin dengan Ø 10 , bahan ST 37	The assembly of the frame is completed followed by drilling of the body mount and electric motor mount parts	
9	Flywhell di frais untuk kedudukan mata potong dengan dalam 6 mm dan panjang 130 bahan yang digunakan untuk ST 37	Starting from the drawing and measurement of the workpiece then the installation of the workpiece to straightening the workpiece, determine where the feeding is so that it is not more than we want, because there are 3 equal parts, then adjust the workpiece to that part.	

4. Conclusion

This research has successfully designed and built an organic waste shredding machine with a shredding capacity of **63 kg per hour**. The machine is designed to handle organic waste such as leftover vegetables, fruits, and foliage.

Using a 6.9 kW **electric motor**, the engine is able to generate enough torque and revolutions to efficiently and sustainably chop organic waste. The cutting system design that adopts rotary blade and belt transmission system successfully optimizes the load distribution and overall performance of the machine. The enumeration process is stable, with uniform enumeration results and appropriate particle sizes for further composting.

The use of this machine can help significantly reduce the volume of organic waste at the source, accelerate the natural decomposition process, and support source-based waste management programs. The machine also shows good performance in terms of energy efficiency, ease of operation, and implementation potential.

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