Designing portable chopping plastic waste machine utilizing electric motor

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Abstract. Waste management in Indonesia is still a problem that can not be handled properly. Waste reduction activities both in the community as waste producers and at the level of the area is still small, so the waste is disposed to the final processing place (TPA) while the landfill is very limited. Plastic waste is a waste that needs to be handled properly, because plastic waste is a waste that can not be broken down by microorganisms. Plastic waste can last for years causing environmental pollution. The design of a portable plastic waste counter machine aims to create a waste recycling tool, so that waste can be recycled into useful items and and create an environmental balance. To focus the manufacture of this crusher, the manufacture is limited to making non-organic waste composting machine design that is plastic waste. The design results are expected to be applied properly and can destroy the waste into granules so it can be reprocessed. The hope of this recycling process is to reduce the amount of plastic waste and make it an item that has economic value.

1 Introduction

Along with the development of the era, the problems caused more diverse, one of which is a garbage problem that is very difficult to overcome. One garbage is non-organic waste in the form of plastic, until now the problem can not be handled optimally and professionally. Whether we realize it or not, rubbish now becomes one of the most important, even essential parts of human life, because the plastic waste that is formed from the remnants of the use of materials, the practical use of packaging products more and more need space and place for disposal which further narrows the space that humans need in their daily activities. The number of people and also their needs causes more space to be used and the narrowness of space used as a final dump (TPA). Garbage causes a hygienic natural balance is difficult to maintain, it is necessary that the arrangement of space between humans and waste must be managed as well as possible.

Waste management technology used previously is the same technology that will be used in this design is the same function to reduce the amount of plastic waste. The difference in design and construction to be used is smaller, its gear ratio uses pulleys and can also be moved from one place to another. Study on previous research is on research conducted by Ichlas nur,

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et al. [5], entitled "the development of a plastic garbage disposal machine with a crusher system and a reel type cylinder" became the basis for redesigning a plastic garbage cutter machine for the purpose of reducing plastic waste.

The design of this machine is expected to reduce the amount of plastic waste for the environment. The impact of plastic waste on the environment, among others, is the contamination of soil, ground water, and underground creatures. The toxins from the plastic particles that enter the soil will kill the decomposers in the ground like worms. Particles that can not decompose even if eaten by animals or plants will become toxic chain in the order of the food chain. Plastic bags will disrupt the waterways that seep into the soil, decrease soil fertility because the plastic also prevents air circulation in the soil and space of underground creatures that are able to fertilize the soil [9]. Plastic waste that has not been completely wasted can interfere with human health, because palstik garbage can become a den of disease.

According to purwaningrum [9], based on data from the Ministry of Environment and Forests that the total amount of waste in Indonesia in 2019 will reach 68 million tons, and plastic waste is estimated to reach 9.52 million tons. In addition, Jeena Jambeck's research results in purwaningrum [9] stated that Indonesia in 2015 is ranked second in the world of plastic waste to the sea which reached 187.2 million tons. The Ministry of Environment and Forestry targets a reduction of more than 1.9 million tons of plastic waste by 2019. The handling of plastic waste that has been widely applied is with the 3R (Reuse, Reduce and Recycle) Concepts and the final solution is to make waste into value goods economical.

The design of garbage chopper machine aims to create waste recycling tools, especially plastic waste, so that waste can be recycled into useful goods and have economic value. To focus the design of this enumerator machine, the design is only limited to the manufacture of plastic garbage disposal machine design. The design result is expected to be applied properly and can enumerate the waste into granules, the final result of the garbage granules will be converted into a goods that have economic value so that plastic waste can be reduced and the management earn income.

2 Literature review

2.1 About waste

The definition of waste in Law No. 18 of 2008 on Waste Management mentioned waste is the rest of the daily activities of humans or natural processes in the form of solid or semi-solid in the form of organic or inorganic substances are biodegradable or can not decompose which is considered to be no longer useful and discarded environment [11]. The main source of the existence of waste is from the settlement of citizens. In a settlement is usually a waste generated by a family living in a building or dormitory. Types of waste generated are usually organic, such as food waste or wet waste, dry, plastic ash and others. In addition, the source that contributes to the role of increasing the amount of waste is from the trading activities of society and industry. Public places are places where people can gather and do activities. These places have considerable potential in producing waste including trading places such as shops and markets. Types of waste generated generally in the form of food scraps, dry waste, ash, plastic, paper, and cans and other garbage. In addition, similar factory production activities also increase the increase of waste. In this sense including factories, timber companies and others, industrial activities, whether including the distribution or processing of a raw material. Garbage generated from this place is usually wet trash, ash dry waste, food scraps, and the rest of the building materials.

2.2 Type of waste

Types of waste that is around us is quite diverse, there is a household waste, trash trade, and industrial waste. According Priyanto [8], solid waste is divided into two, namely organic waste and also inorganic waste. Organic waste is waste generated from biological materials that can be degraded by microbes or biodegradable. This waste can easily be deciphered through a natural process. Household waste is largely organic. Including organic waste, such as kitchen waste, food scraps, wrapping (other than paper, rubber and plastic), flour, vegetables, fruit peels, leaves and twigs. While the meaning of inorganic waste is waste generated from non-biological materials, either in the form of synthetic products or the process of processing technology of mining materials. Inorganic waste is divided into metallic waste and its processed products, plastic waste, paper waste, glass and ceramic waste, detergent waste. Most of the inorganic can not be decomposed by nature / microorganisms as a whole (unbiodegradable).

2.3 Diseases caused by the presence of waste

Waste reduction activities need to be done along with the increasing amount of waste in the environment. The existence of this waste has a bad impact on human survival, especially for human health. As according to Priyanto [8], there are some diseases caused by the presence of garbage, such as:

- Diarrhea, cholera, typhoid disease spread rapidly because viruses from waste with improper management can mix with drinking water. Dengue fever (haemorhagic fever) can also increase rapidly in areas where waste management is inadequate.
- Diseases that can spread through the food chain. One example is a disease that is infected by a tapeworm (taenia). This worm previously entered into the farming of livestock through food in the form of food scraps / garbage.
- Fungal diseases may also spread (eg skin fungus).

2.4 Waste handling

From the above data it can be concluded that the handling of garbage is serious, by a very lucrative responsibility for humans. Handlers that can be done like waste recycling process. The process of recycling waste can be done on organic and non organic waste. Recycling of this waste should be focused on non-organic waste, such as plastic waste. Plastic waste belongs to waste that can not be broken down by microorganisms / unbiodegradable. The process of recycling garbage using garbage using plastic garbage disposal tool. By using this tool, waste can be small pieces and can be reprocessed into goods that are renewable and have a sale value. The process of recycling is with the principle of waste management, ie Reuse by reusing goods, Recycling by recycling waste, and Replace goods with the same goods with the longer items. One example of plastic waste recycling to become finished goods is plastic waste into a bag [4].

2.5 Waste handling using chopper machine

The waste handling process is by using a real type garbage enumerator machine. In general, for a plastic waste can be processed by an industry, among others, waste must be in certain forms such as grains, seeds / pellets, powders, fractions, for it required several interconnected machines, such as plastic waste counter. This plastic chopper machine works with a process that is a preliminary enumeration process with a crusher system. Use of this crusher has been done for the process of enumeration of other solid waste materials.

The crusher model is used to damage the structure of the material and reduce its thickness so it will be easier to enumerate. Cutting results obtained by the results of chopped in the form of small pieces. To improve the efficiency of the enumeration process, efforts need to be done to minimize the size of the material by enumeration using crusher with this condition the material becomes more soft and the garbage becomes small pieces. The crusher counter unit consists of two cylinders of opposite counter, the cylindrical blades of the counter are arranged in a circle each of which is shaped like a disc-shaped metal tooth.

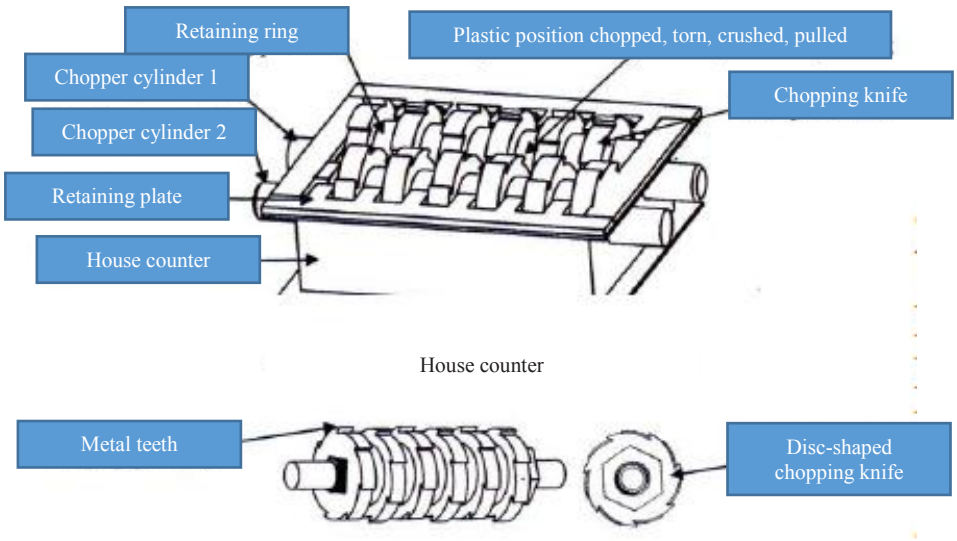


Fig. 1. Waste chopper machine type *crusher* [5].

2.6 Electric motors as drivers

The driving force used in this machine is by electric driving power. Arisworo, explained that electric motors use principles that are almost the same as the electrified aluminum ribbon that is placed in the magnetic field [1]. As a result of the existence of a magnetic field, electric current can work into mechanical power. This is in line with Lulukwatil [6], an electric motor designed to convert electric power into mechanical power. To control various equipment such as production equipment and so on. The power generated so that the enumerator can move is by using power of 4 hp or equivalent to 4 pk. The use of electric motors with 4 hp power has also been used by Sutrisno [10], as a driving machine water pump. 4 hp power can raise water from the water hole well, thus, the use of electric motor can certainly be able to rotate the shaft of enumerator on plastic garbage chopper machine. Another application which is suitable for use in a garbage disposal machine is the use in a poultry-plucking machine by means of a pulley-reduction drive supplied by the v-belt, thus the use of an electric motor is not too heavy to rotate the counter shaft. Use of v-belt suppliers using electric motor drives using small pulleys and movable axles using large pulleys [3]. Selection of electric motors as a driving force because the electric motor has several advantages compared with other movers. Electric motors have several advantages compared to other drivers are wide working speed limits, variable power size, no pollution, easy operation and maintenance, can be controlled automatically or manually, and also compact places [2]. Another advantage of electric motors according to [12], is by not using fuel oil, therefore fuel oil is now increasingly scarce and the use of electric motors is a solution to minimize the use of fuel oil which impact on the scarcity of fuel oil.

Fig. 2. Electric motor [13].

Making the framework on the garbage chopper machine is as a support of the chopping knife. The material used as a framework is iron, hence iron has stronger strength than other materials such as wood if used in the long term, but also has lighter construction than steel. The iron used as a frame is a square hollow iron [7].

3 Designing method

The process of making a product in the form of a tool can not be separated from a design method. The method of shaking is a method used in the design process, the process of making up the process of goods into a product that can already be used. The method of completion contains a plot design of a plastic garbage disposal machine, illustrated in the following design flowchart:

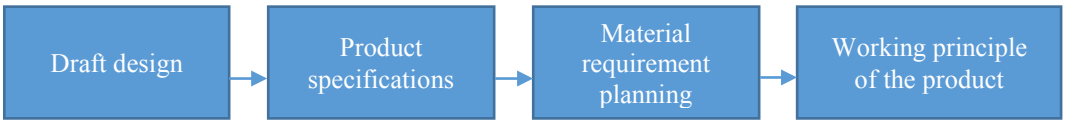


Fig. 3. Design flow and product design (adopted and adapted from Sutantra & Sampurno, 2010).

4 Discussion

4.1 Initial draft concept (*draft design*)

The design of this plastic garbage disposal machine is a development of the previous plastic garbage cutter machine. In accordance with the purpose, this design aims as a tool that can be used to reduce the amount of plastic waste that can not be decomposed into a processed goods and have economic value. As a differentiator from the previous design, this tool has a difference in the input funnel and also on the output funnel so that the processing becomes easier on one side of the place. In addition, the design of the input funnel is made larger, so that the volume of garbage storage during the processing process becomes large. The working system of this garbage chopper machine uses the reduction in ratio ratio on the pulleys, so the performance of the machine during the enumeration process is not too heavy. Driving machine using an electric motor with 4 hp power to be able to move the knife during the process of enumeration. The design of the product to be made is as follows.

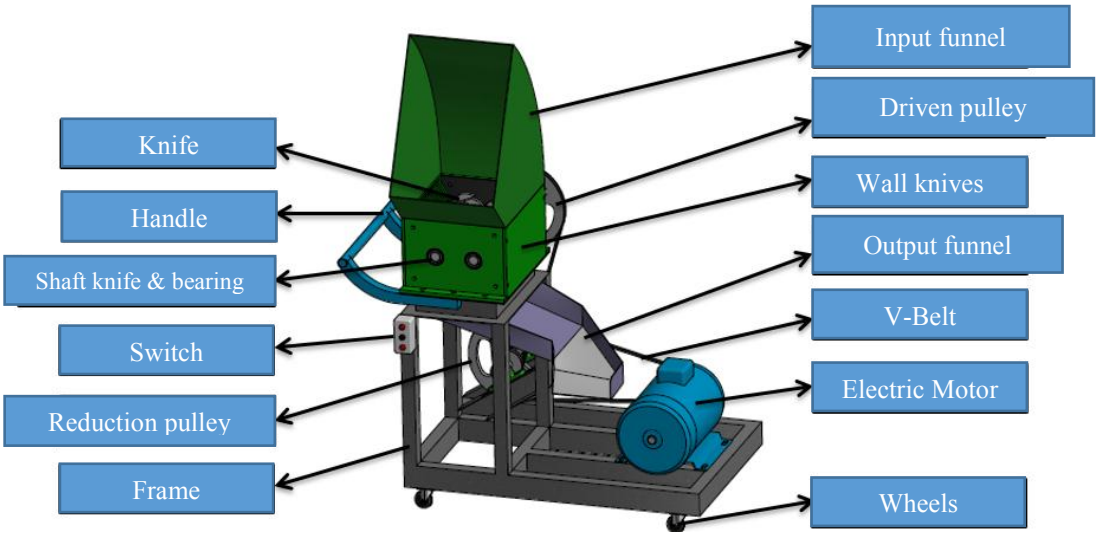


Fig. 4. Portable chopping plastic waste machine utilizing electric motor as a whole.

4.2 Product specifications

4.2.1 Dimensions of machine

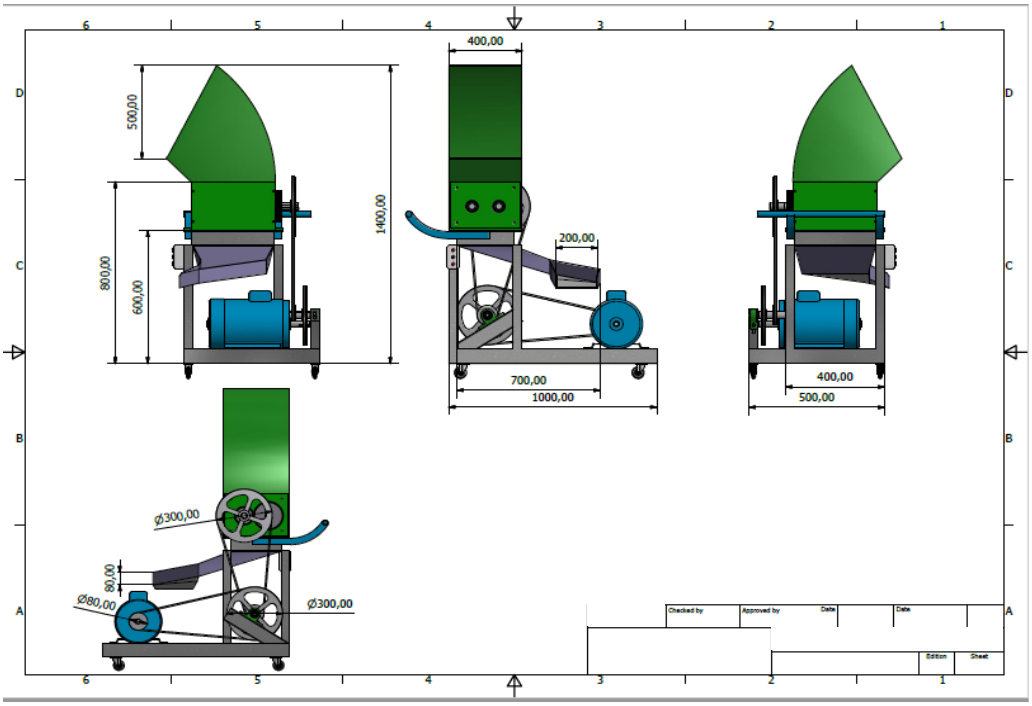


Fig. 5. Dimensions of portable chopping plastic waste machine utilizing electric motor.

4.2.2 Machine components

The plastic waste counter is designed with 16 components assembled into one system, the components are as follows.

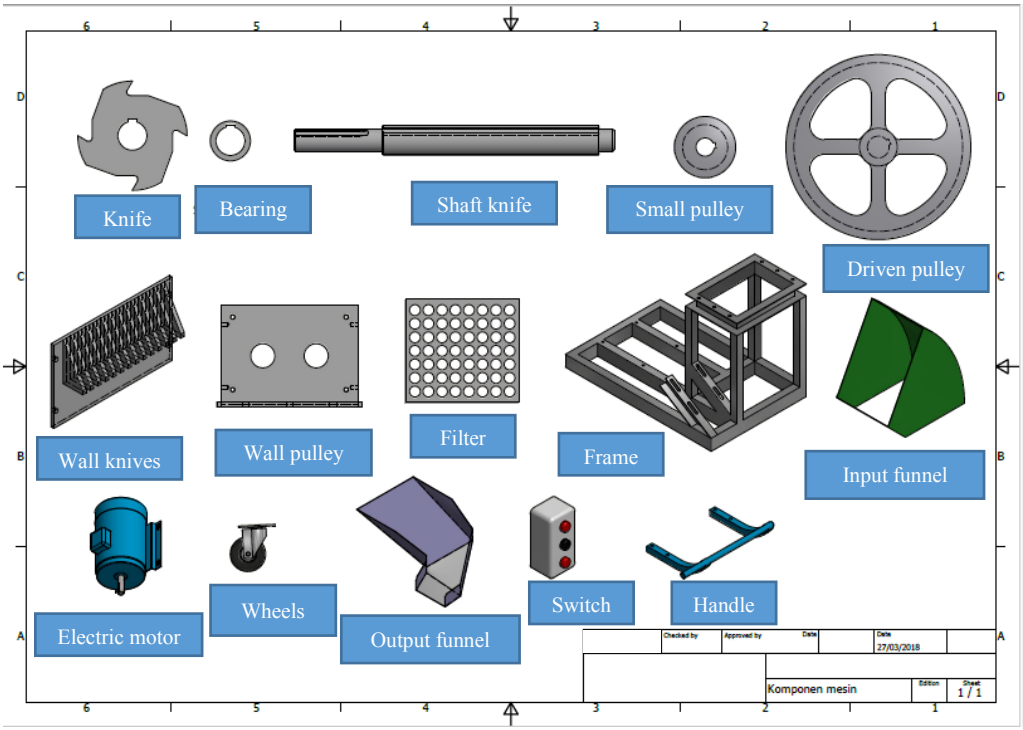


Fig. 6. Components of portable chopping plastic waste machine utilizing electric motor.

Table 1. Machine component data.

Component Name	Function	Dimensions	Material	Information
Knife	Knife serves as a garbage counter when the waste is inserted into the machine so that the waste into small plastic pieces.	This blade is 6 in one axis, the total is 12 knives.	Carbon iron (carbrida)	Energy used from electrical energy to motion energy.
Blade knife	Blade sticker serves as a baffle between one blade with the other and also as a waste scraper.	This blade attachment amounts to 6 on one axis, a total of 12 knots in total.	Iron	Energy used from electrical energy to motion energy.
Shaft knife	The shaft of the knife serves as a place for the knife, knife, and knife rotation during the enumeration process.	A shaft of this knife contains 6 knives and 6 knife blockers, at the end there are gears and pulleys as drives. 3 cm in diameter.	Iron St 90.	Energy used from electrical energy to motion energy.
Pulley drivers (small).	This pulley serves to reduce	Diameter of 8 cm. The number	Iron.	This Puli in pairs on the electric

Component Name	Function	Dimensions	Material	Information
	power so that electric motor performance becomes light.	of pulley is 2.		motor and also on the pulleys in the movement (large pulley)
Driven pulley (large).	This pulley serves to reduce power so that electric motor performance becomes light. This pulley moves the shaft of the blade so that the blade can move .	Diameter of 30 cm. The number of pulley is 2.	Iron.	The pulleys are driven by a (small) drive pulley. Puli is driven by electric motors through v-belt.
Wall Knives.	The walls of knives are designed with the bulkhead so that during the process of enumerating garbage, the waste becomes small pieces.	Wall length 40x40 cm with height 20 cm.	Iron plate.	The wall of the blade is made with a rectangular shape as a container of the shaft of the blade.
Filter	This filter serves to separate the waste that has been through the enumeration process that has become a small part with large garbage still needs to be done again enumeration process.	The filter length is 40 x 40 cm with a thickness of 3 mm. Construction of the filter is made perforated.	Iron plate.	The number of filters contained in this machine there is 1 piece of filter.
Frame	This frame serves as the seat holder of all components, both from (electric motors, knives and counter walls, pulleys, wheels).	Length 1 meter, width 50 cm, height 60 cm.	Hollow iron rectangle.	
Input funnel	This funnel is input from plastic waste during the enumeration process.	40 cm long funnel, 40 cm wide, 60 cm high.	Iron plate.	
Electric motor	Electric motor serves to move the pulleys and	1 piece.	Electric motor components.	

Component Name	Function	Dimensions	Material	Information
	also the chopping knife.			
Wheels	Wheel as a lever of the frame, this wheel serves to make it easier at the time of removal of the machine.	Wheel on the framework of 4 wheels.	Iron and rubber.	
Output funnel.	The output funnel serves as the channeling of the enumerated waste.	1 piece.	Iron plate.	
Switch	Switch as button on and off machine.	1 piece.	Plastic and brass.	The switch is connected to an electric motor and an electric outlet.
Handle	The handler serves to ease the process of moving the machine.	1 piece.	Iron hollow.	
V-belt.	As a liaison between the drive pulle with the moving pulleys.	Number of 2 pieces.	Rubber.	
Bearing	This bearing serves as a pivot and pulley axle in order to spin.	Diameter 6 cm. Number of bearings 7 pieces.	Iron.	

4.3 Material Requrement Planning (MRP)

As for the material needed in the design of plastic waste collection tool contained in the table below.

Table 2. Data of material used

Component Name	Number of Components	Information
Knife (chisel enumerator)	12	The purchase price is made into one set.
Knife Shaft	2.	Purchases are included in the backup when a manufacturing failure occurs.
Pulley drivers (small)	2	The pulley is connected to the electric motor shaft and also to the counter reduction shaft.
Driven pulley	2	This pulley is connected to the counter reduction shaft and also on the chisel count of the enumerator.
Thick iron plate.	PxL= 1x1 meter.	This pulley is connected to the counter reduction shaft and also on the chisel count of the

Component Name	Number of Components	Information
		enumerator.
Thin iron plate.	PxL= 3x3 meter.	This iron plate is used as a knife wall.
Hollow iron plate	40x40 cm	This iron plate is used as an inlet and outlet funnel.
Iron hollow.	6 meter	Hollow iron plates are used for sieves.
Electric motor	1	Hollow iron is used as a frame.
Wheels	4	Purchase an electric motor with 4 hp power to drive the chisel at the time of garbage collection process.
Bearing	7	Purchase price in one set.
Switch	1	The bearing price adjusts to the bearing quality.
V-belt	2	Switch as on off machine.
Iron hollow pipe.	1 meter.	As a liaison between small pulleys with large pulleys.
Putty	1 tin	This iron is made as a handle when moving the appliance. The purchase price is calculated in one meter.
Paint	1 tin	This putty to smooth the surface of the frame during the painting process.
Sandpaper	10 sheets.	To beautify the plastic waste counter.
		To soften the surface to be in putty and in paint.

4.4 The working principle of the product

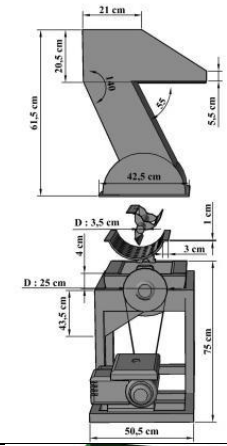
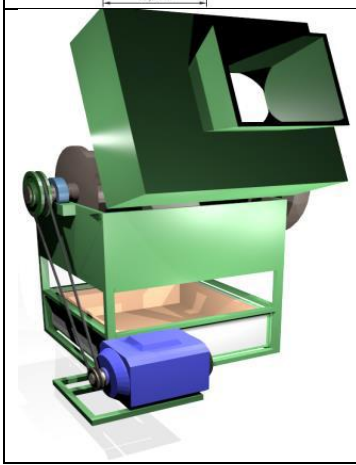
The working principle of the platik trash machine that is electric motor is turned on by pressing the on button on the switch, then plastic waste is entered through the funnel entrance. After the garbage enters the funnel, the waste through the enumeration process is by rotating the chisel driven by the electric motor through the reduction in the pulleys. Switch power from the electric motor through V-belt and pulleys. The next stage is the enumeration, plastic waste will be cut and squashed on the chisel so that the garbage becomes a small part. After going through the chopping process by the chisel, the trash then descends and is filtered by a sieve. At the time of this screening process the garbage that has become a small part can continue towards the funnel out and the large garbage will be accommodated and will be replicated back. The last performance of the enumeration process is garbage out through the funnel out and accommodated on the container. After the enumeration process press the button off on the switch to turn off the machine.

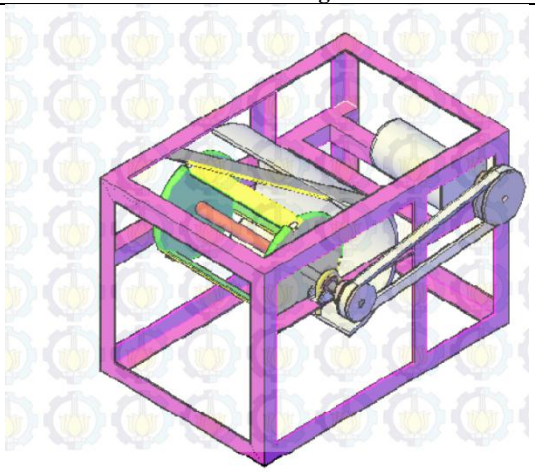
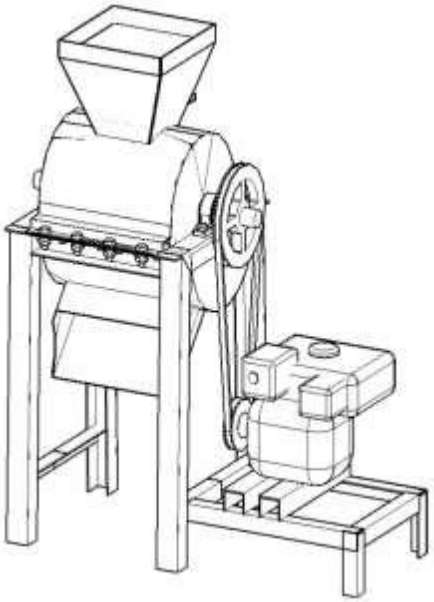
4.5 The advantages of this machine compared with the previous one

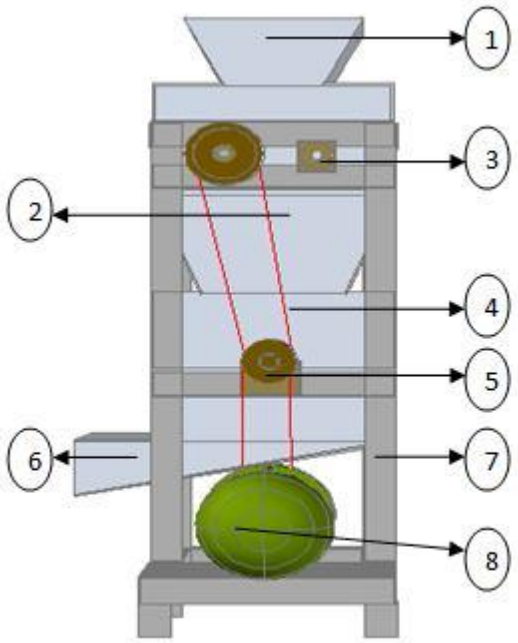
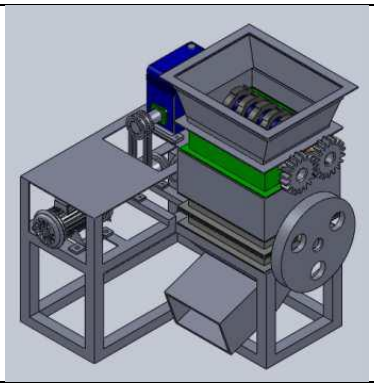
This is the advantage of Portable Chopping Plastic Waste Machine, among others: 1) portable; 2) the product is designed in such a way as to avoid failures that may occur in the manufacture of a product, in this case the product in question is plastic waste; 3) the product is made by choosing the best and most economical method; 4) any product specifications are made; 5) the product is made as economical as possible in the use of raw materials and costs with no lessening of the product sale value. For some types of product

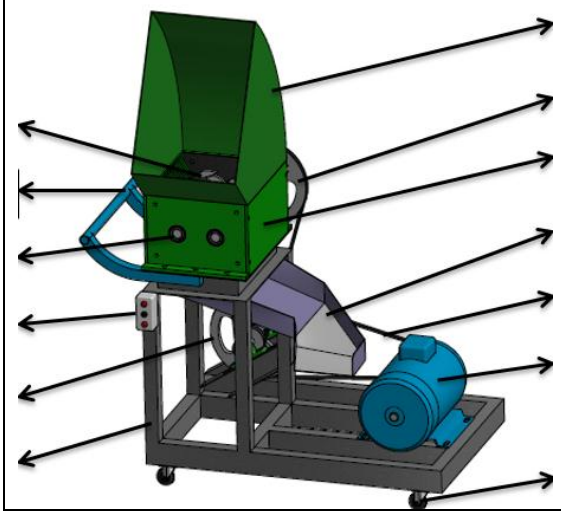
categories, such as engines, designs and models are very decisive sales results, including in this design is the color selection. The design of this machine product is compared to that previously visualized in Table 3.

Table 3. The design of this machine product is compared to the previous one

Drawing	Machine Name	Information
	Plastic counter machine	-Designed by Syamsiro, et al. [14]. -Material plastic: PET bottle -Weight (gram): 700 -Time (minutes): 3 -Power loop axis (RPM): 450 -Portal axis during enumeration (RPM): 350-380
	Electronic Plastic Bottle Plastic Machine	-Designed by Prakoso. [15]. -Material plastic: plastic bottle -Using an iron material with a thickness of 8 mm Tool dimensions 37 x 35 x 110 cm (P x L x T). -Using Arduino as a programming application created for the main control of the weight gauge.

Drawing	Machine Name	Information
	Plastic glass counter	-Designed by Grestananta, et al. [16] -Cutting force of 2.2 kgf -Received 0.15 HP -Belt used type A with length 710 and age belt 80734,56 working hours -The pore is 8.9 mm in diameter with AISI 1040 material. In application using 10 mm diameter -Upper pads 2878397.5 working hours
	Plastic counter machine	-Designed by Upingo, et al. [17] -Stand of frames, plastic containment funnel, transmission system, propulsion and outlet funnel. -The blades use stainless steel and high carbon with a thickness of 10 mm. -Wall machine made of eser plate with thickness 1.2 mm. -Power 5.5 HP -Capacity effective plastic counter 30 Kg / Hour.

Drawing	Machine Name	Information
	Plastic bottle counter	-Designed by Satyawan [18] This plastic garbage chopper transmission system converts electric motor rotation from 2100 rpm to 600 rpm on the shaft 1 and 1200 rpm on the 2 axle, with components of 3 pulley 104 mm diameter, 182 mm and 364 mm connected by v-belt type A . - Design of this plastic garbage bottle enumerator machine requires power from the electric motor of 0.95753 kW - The capacity of this plastic bottle disposal machine is 1.5 kg / hour.
	Plastic Counting Machine	-Designed by Junaidi, et al. [19] - This machine has been made with theoretical capacity of design result ± 200 kg / hour and test result ± 195 kg / hour.

Drawing	Machine Name	Information
	Portable Chopping Plastic Waste Machine	-The advantages of this machine are portable

4.6 Work tool capacity

According to Irwanto (1983), the working capacity of a machine or tool is the ability of the machine or tool to deliver the result (hectare, kilogram, liter) unity of time. Measurements: 1) weigh the material to be counted as much as 10 kg, 2) operate the machine up to the optimum rotation, then insert the material to be chopped through the input hole (input), 3) after the material is out through the outlet or output hole tamping (5) then weigh and record the weight of the material that has been chopped, 6) the test is done only 1 (one) time, 7) the production capacity of the machine is hollowed based on formula [20] as follows:

$$C = \frac{W}{t_1}\ x\ 3600\ sec. = kg/hour$$

$$C = \frac{1}{0{,}15}\ x\ 3600\ sec. = 6{,}45\ kg/hour$$

Where:
C = Engine work capacity (kg/hour)
W = Material weight (kg)
t_1 = Time of enumeration (hour)

5 Conclusion

Plastic garbage disposal machine serves as chopping plastic waste into small granules. Function of this tool to reduce the amount of plastic waste that cause pollution to the environment. The use of this tool can be applied directly to the community in order to reduce plastic waste generated from many community activities. Rubbish from the grind can later on if back into an item that has a sale value.

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