# Design and fabrication of multipurpose organic chopper machine

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**Abstract.** This study aims to design and fabricate multi-purpose organic chopper machine by utilizing local components. Research includes the design of construction, cutting tools and working mechanisms that are in accordance with user needs. The method used in this design is the most optimal component selection, strength analysis using structural analysis software, manufacturing and testing of product prototypes. The result of this study is a multipurpose organic chopper machine prototype with a capacity of 600 kg/h, able to cut organic waste to size ranging from 1 to 50 mm, and can be operated easily by the user. This result is one of the references in the development of the next multifunctional organic garbage counting machine. Keywords: design, multi-purpose organic chopper machine.

## 1. Introduction

Garbage is often a problem in environmental management. Every day, thousands of tons of waste will be produced in various types as the result of extensive community activities. In general, waste can be divided into organic waste that can be recycled and waste that cannot be recycled. Waste that can be recycled, especially the organic one, can be utilized as animal food and organic fertilizer. Organic waste originates from household, agricultural, plantation and food production activities from a food industry. During this time, there are organic waste that has been put to good use and some are still thrown away to landfills. Seeing a great opportunity to utilize organic waste, especially from agricultural and plantation products, this research has designed a waste counting machine from agricultural waste [1], [2], [3], [4]. The purpose of designing this multifunctional garbage chopper is to produce a machine that can be used to chop up to a certain size, so that the waste produced can be easily utilized into other forms such as animal food and compost fertilizer. The design of a multifunctional garbage chopper includes the calculation of machine construction and cutting knife and making prototypes of organic waste chopper products. The resulting machine is expected to be used to facilitate the management of waste into useful materials for the next process. In general, the design of a multifunctional organic garbage chopping machine consists of a motor that functions as a drive, transmission system, casing, frame shaft, and chopper knives [1], [2], [5], [6]. Things that must be considered in making this chopper machine is how to make a machine that is ergonomic, affordable, and easily available on the market with a strong frame anda sharp bladeto perform several times of cutting. Chopper machine must function optimally according to its functions and needs and can be operated easily and safely [7], [8]. Ease of use and comfort in the work process is necessary to increase the productivity of machine users in carrying out the process of displaying waste according to the capacity produced by this multifunctional chopper machine.

## 2. Method and material

The design method used in the design of this multifunctional chopper machine is the VDI 2221 (Verein Deutcher Ingenieure) method. This design method is one of the methods to solve problems and optimize the use of materials and technology based on economic conditions. Ideas and knowledge are basic sources of product design to meet consumer demand and for the benefit of all parties. The design with the VDI 2221 method is divided into several stages as follows: Classification of the Task, Conceptual Design, Embodiment Design, Detail Design, Prototyping and testing of design machines [5], [6]. Some things to consider in the design of multifunctional chopper machines are as follows: safety, functionality, comfort, operation, power using a diesel motor, easy to obtain, low-priced, yet good quality material, low production costs,ease of manufacture, low maintenance costs, easeofmaintenance, the results of the slitting as needed, fuel saving and low noise levels (Figure 1). The design starts with the making of a chopper machine design, cutting knife design, transmission system design, cutting mechanism design, analysis of construction strength using software, making prototype products, testing and repairing, and ends with the use of machines in the process of chopping organic waste. The design limits are as follows: The work capacity carried out using tools made in the final project is 600 kg per hour; materials to be processed include straw, elephant grass and leaves; the influence of the shape and working position of the existing equipment; mobility tools are designed to be easy to move; discussion of fixed connections in frame construction, and shape construction of machine frame sizes. Specification of multifunctional chopper machine: power using a diesel motor 8 HP, pulley 102 mm (2 pieces), v-belt B-30 (3 pieces), shaft S45C, ∅38 mm.

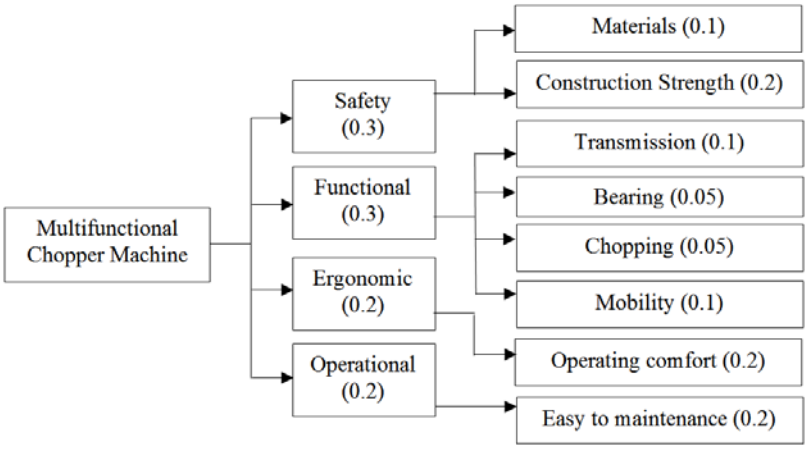


**Figure 1.** The design focus of the multifunctional chopper machine [1], [2]

## 3. Result and discussion

A multifunctional chopper machine design has been done using local materials that are freely available on the market. The method used is the component selection method using the VDI 2221 method. The design of cutting blades using knife material used in multipurpose organic waste crusher refers to the SNI 7580: 2010 standard, HSS (High Speed Steel) material. The material recommended for the chopper blade material is hard steel with a minimum hardness requirement of 45 HRC [9], [10], [11]. The selected cutting angle of $30^o$ is the optimal cutting angle obtained based on the distance between the blades designed at 52 mm (Figure 2). If the knife has a cutting angle that is more than $30^o$ or less than $30^o$, the speed

of the chopping to get to the disposal section will be reduced because the contact angle that occurs becomes too large or too small so that the chopped direction will not lead to the next arrangement of the blade. The number of knives used is as many as 15 pieces with the division of 3 knives in 5 arrangements with an installation angle of 120$^{o}$, which is the optimal number because the enumeration target of 0 - 50 mm has been reached. If the number of blades is increased, it will reduce the effectiveness of work and increase the load on the shaft with less significant changes in yield. The chopping output system chosen in the form of a exhaust fan has proven to be very effective in terms of both work effectiveness and cost because it speeds up the process of removing chopped products by not adding other parts such as screw conveyors which will increase costs but cannot provide an increase in work speed as well as the exhaust fan [10], [11], [12], [13], [14].

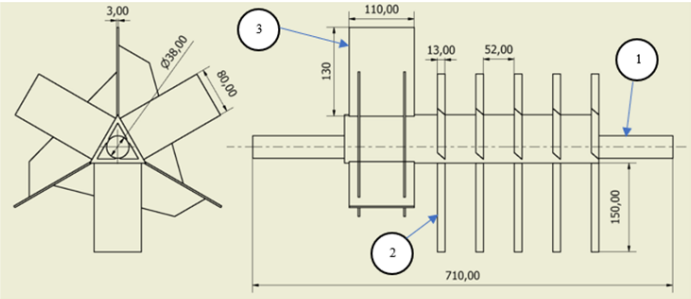


**Figure 2.** The knife of chopper machine design [1], [2]

To determine the loading of the existing force on a construction that has been designed and added to the load of each part of the design, the analysis of stress that occurs in the construction is done according to the design. In the right frame there are parts in the form of tubes, shafts, bearings, and pulleys. This section has a downward force of 564N. While the right side of this tool has a loading force of 810N. The connection used in this design is a permanent connection to the welding process.The maximum value of von mises stress on the loading force is 4.02 MPa (Figure 3).

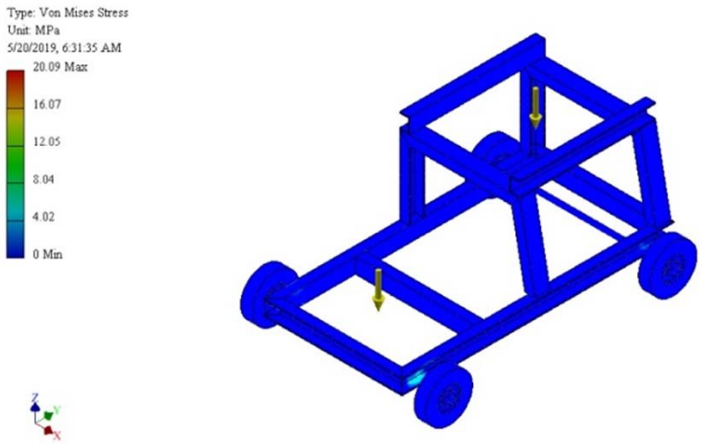


**Figure 3.** Stress distribution of chopper machine construction [1], [2]

The maksimum stress is experienced at the connection point under the frame to the axle. This stress occurs because this part is the most basic loading point in the design. This point is also connected by using a welding process. In this design, maximum deflection occurs in the part where the power transmission occurs. Deflection has a large value in this section due to the tensile force in the v belt. Tensile force between the shaft pulley with the motor pulley causes the possibility of shifting or the frame being slightly curved downward. The maximum deflection in this design is 0.0921 mm (Figure 4).

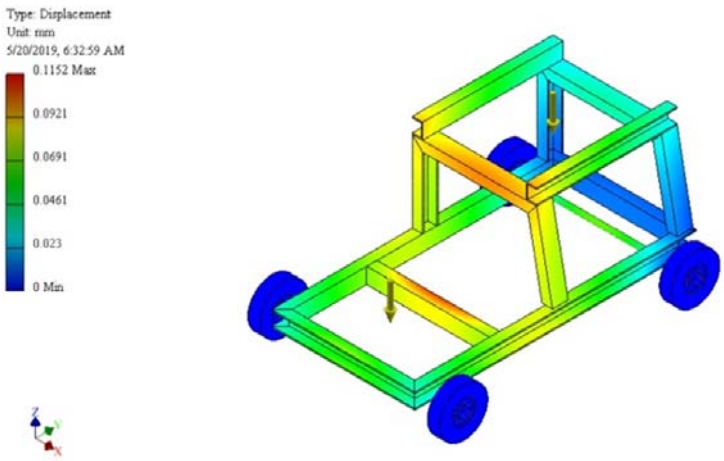


**Figure 4.** Deflection distribustion of chopper machine construction [1], [2]

The multifunctional organic garbage chopper machine has been tested for working capacity 5 times. The final result obtained is 794.8 kg/h. The resulting capacity is more than what the designer wants which is 600 kg/h. This can be caused by the speed in entering organic waste in the tests that are too fast and the maximum rotation used at 2432 r/min while at the time of design a minimum rotation of 1700 r/min is used. Up to 96.48% of the chopped organic garbageas the result of the testing done 5 times with a sample of 100 g have length below 50 mm while only 3.52% of them have length above 50 mm. Thus, this design has produced a prototype of a multifunctional organic garbage chopper machine that can work well and can be further developed.

a.The knife chopper machine b. Prototype of chopper machine

**Figure 5.** Prototype of chopper machine construction [1], [2]

## 4. Conclution

A multifunctional organic garbage chopper machine has been produced by utilizing local materials that are freely available on the market. This machine is very useful for turning

organic waste into useful products such as animal food and compost. The result of this study is a multipurpose organic chopper machine prototype with a capacity of 600 kg/h, able to cut organic waste to size ranging from 1 to 50 mm, and can be operated easily by the user. The prototype of the mutifunction chopper machine will be a reference in the development of the next product, so as to produce a product that is useful for the community in utilizing waste into useful products.

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