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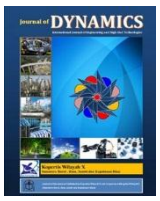

Design And Development Of Chopper Machine For Palm Oil Midrib

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Abstract

The midrib of palm oil has good potency to be processed become animal feed (silage) and compost where the midribs are chopped into small pieces. The opportunity of this development process that can more be benefit and valuable encourages researcher to design and create a machine that capable to chop the midribs of palm oil. In this research, researcher designs and creates a chopper machine which can be operated safely and more efficient based on ergonomics approach. Researcher also uses anthropometry method with 30 samples and collecting creative ideas through brainstorming to produce a best design. The chopper machine has certain dimension determined by anthropometri data calculation through test data sufficiency, uniformity test data and calculation of percentil and had been obtained 107.85 cm for height, 120 cm for length and 58 cm for width. The chopper machine also uses 4 blades and working based on clockwise direction.

Keywords: Anthropometry, design of machine, ergonomics.

1. Introduction

Dumai is one of cities in Riau province, exactly located in the east coast of Sumatra where the main profession of society is as palm oil farmer. Generally oil palm fruit is harvested and processed to be CPO (crude palm oil). In the process of harvesting, the midrib must be cut to simplify of harvesting process.

Midribs that had been cut are usually discarded and finally would be burned by the owners. Whereas it can be chopped to be small pieces thus can be used as animal feed (silage) and compost.

In this research, the author will design a chopper machine for palm oil midribs and named "Design and development of chopper machine for palm oil midribs" where the basic principle of this machine is to chop the midribs to be small pieces.

This machine also uses gravity to drop off midribs and entered from above thus the blade can easily chop the midribs. However, the working principle of machine is blade would be rotated by belting, thus the midribs are cut by blade to be small pieces.

Design is a process that aims to analyze, assess and construct a system, either physical or non-phisycal system and expected to optimize the value and efficiency. Designing of a machine uses technical method, thus all steps of design must follow this technique.

Nowadays, design of chopper machine for palm oil midribs have been developed in various places with different size and capacity. In fact, there was related information about current developed chopper machine for palm oil midribs as described below.

Ginting [1] with title of research was "Technical and economical evaluation of

chopper machine for palm oil midribs with BBP Mektan design as raw material of compost". This research aimed to calculate capacity and quality of machine and also analyze the economical of machine used completely randomized design (CRD) analysis. This research was conducted with 1 replacement of pulley in the pulley input with 4.5 and 2 inch for three repetitions where the raw materials used for each test were the palm oil midribs.

A. Definitions Ergonomics

The ergonomics is derived from the Latin "Ergo" means Work and "Nomos" means rule or principle. In the other word, the ergonomics is a study that describes relationship between human and its work. In detail, ergonomics can also be defined as a study about human aspects in work environment that is reviewed from anatomy aspect, physiology, psychology, engineering, management and design. Ergonomics also are related with efficiency, health and safety [2].

B. Definition Anthropometry

Antropometry is one of parts for supporting ergonomics, particularly in designing a tool or machine based on ergonomic principles. Antropometry is derived from the Latin "Anthropos" means human and "Metricos" means dimension. However, Antropometry also can be defined as something which related to the physical geometry, mass, and strength of body [3].

C. Percentile Anthropometry

Statistically, the size of the human body in certain population will be concentrated in a central value, and a small part of the extreme values will be on both sides of the curve distribution. Therefore, there is an election in the middle of distribution where most of the values will be concentrated or centralized [3].

Most of Antropometry data expressed into persentil form. A population for studying divided into hundred percentage categories where the values will be sorted from smallest to largest on a particular body size. The percentile indicates a certain percentage of people who have size above or below that value [3].

The use of percentile value commonly applied in the calculation of antropometry data that can be explained in the following table.

Table 1 . Wide percentile and the method of calculating the normal distribution [3].

Percentile	Calculations
1 – St	- 2.325 σx
2.5 - th	- 1.96 σx
5 – th	- 1.645 σx
10 – th	- 1.28 σx
50 - th	——
90 - th	+ 1.28 σx
95 -th	+ 1.645 σx
97.5 -th	+ 1.96 σx
99 - th	+ 2. 325 σx

D. Diesel Engine

The diesel engine, also known as compression engine is an internal combustion engine that uses heat compression to initiate ignition and burn the fuel that had been injected to the combustion chamber. It is different with the engines that use gasoline or gas as fuel which use a sparkplug to ignite the mixture the air and fuel mixture.

The diesel motor does not require the ignition system like on gasoline motor, but diesel motor need fuel injection system such as injection pump, injector, and another supporting tool. The fuel that is sprayed must have flammable [4-6].

2. Material and Methods

This research was conducted at workshop of SMK Negeri 2 Dumai and had been finished from March 2015 to May 2015.

A. Population and Sample

This research took 30 palm oil workers as population and sample, where the location of plantation was in Kampung Baru, Dictrict of Bukit Kapur, Dumai.

B. Technique of Data Analysis

The technique of data analysis that was used in this research include:

1. The uniformity test data
   The uniformity test data is intended to determine that the population of sample had a normal balancing of the average level of confidence.
2. The sufficiency test data
   The aim of this test is intended to know whether the observed data can be considered sufficient or unsufficient.

3. The calculation of persentil
   Design of this machine had used product design principle that should be operated in certain range of size. In this research, it must be 95th percentile and 5th percentile.
4. The application of data against the machine designed dimensions
   Data that has been tested would be used to design that machine.
   4.1 Data collection
   The data collected of this research were the antropometric data of plantation workers and the results of discussion about product design with lecturers and students.
   4.2 Data Antropometric
   The antropometric data of this research are the high of elbow (vertical distance from the floor to the lowest point in the right part of the right angle). Data would be used to determine the height dimension of palm oil's midribs. However, the size of the sampled elbow could be seen in the table 2 below.

3. Result and Discussion

A. Antropometric Data

Antropometry data that is used to design this machine is the high of elbow (vertical distance from floor to the lowest point at the right-corner of elbow), and then data is used to determine the height of machine. However, Table 2 below indicates the used sample for high of elbow

Table 2. Table of High Elbow Measurement

People Into	High Elbow (cm) X	People Into	High Elbow (cm) X
1	109	16	110
2	108	17	109
3	109	18	108
4	108	19	109
5	109	20	109
6	109	21	109
7	110	22	110
8	108	23	109
9	109	24	109
10	109	25	108
11	108	26	110
12	109	27	109
13	108	28	109
14	109	29	109
15	109	30	108
Σ X		3266	

Uniformity Test Data

Uniformity test data is tested to control which data was rejected and not-uniform because could not meet the specifications.

The high of elbow in standing position From table 4.1 have been obtained the value of elbow's height in standing position, then to find the value of $\bar{\alpha}$ and σ use formula 1 and 2

$$\bar{x} = \frac{\sum x}{N} \; \bar{x} \quad (1)$$

$\bar{x}$ = 3266/30 = 108.87

$$\sigma = \sqrt{\frac{\sum(x_1 - \bar{x})^2}{N-1}} \quad (2)$$

σ = √ (((108,8-109) ^ 2 + (108,8-108) ^ 2 + ⋯ + (108,8-108) ^ 2) / (30-1))

σ = √ (11.46 / 29) = 0,62cm

The uniformity test of high elbow data in standing position with 95% confidence level, then obtained k=2 and with using formula 3 and 4

$$UCL = x + k.\bar{\sigma} \quad (3)$$

UCL = 108,87+ (2 × 0.62) = 110.11 cm

$$LCL = \bar{x} - k.\sigma \quad (4)$$

LCL = 108,87- (2 × 0.62) = 107.63 cm

The results of calculation indicate that upper control limits 110.11 cm and 107.63 cm for lower control limit as illustrated in figure 4.1. Since all of data has been uniformly then continued to sufficiency data calculation.

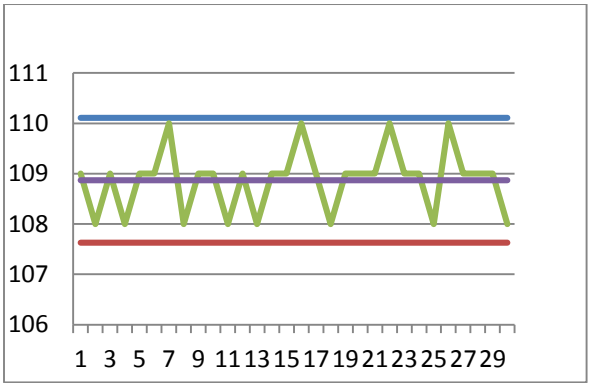

Figure 1 . Uniformity Test Graph Data
Source : Data Processing 2015

Figure 1 explains that:
Lower control limit (BKB) = 107.63 cm
Upper control limit (BKA) = 110.11 cm
Average (CL) = 108.86 cm

Percentile value calculation

Based on data from dimension of high elbow that has been obtained before, then high of machine can be determined by percentile adjustment. Percentile calculated is fifth

percentile and aims to facilitate any operators able to operate this machine. Formula used is:

High of standing-elbow

$$= \bar{x} - P_5 \times \sigma \quad (5)$$

$= 108{,}87 - (1.645 \times 0.62)$

$= 108.87$ to 1.0199

$= 107.85$ cm

Concept of design

In order to have a best design, brainstorming has been done before starting design that machine. However, the concept design of this machine was assumed as general view that representing whole of concept, either about dimensions or position of parts.

B. Determination of dimensional of frame machine

Dimensional calculation is calculated to determine the dimension of design. The calculation is done based on results of persentil where the required dimensional was the dimensional of high machine. Meanwhile, the antropometry data used was the high of elbow. In order to have comfortably, then the high have of machine must be adjusted with the body of operator. The fifth persentil has been used as standard to design high of machine thus the operator who has minimum body dimensions still can operate the machine**.**

Calculation of high engine

In order to determine the high of machine, antropometry data (the high of elbow in standing position) had been used with fifth percentile.

The high of elbow (P5) = 107.85 cm

Width of machine

Width of machine was same with the width of diesel machine, it is 58 cm

Length of machine

Length of machine also has been determined based on the length of drum plus the width of diesel machine. It is 120 cm

Input hole

It has been designed 40 x 20 cm. It assumed will be enough for the biggest midribs.

Output hole

It has been designed 40 x 15 cm. This size can be easily passed by midribs that have been chopped.

Determination of final design

Researcher has been created three designs, firstly was a chopper machine with input from above and output from side. Secondly was a chopper machine with input from side and output from front, and finally was a chopper machine with input from above and output from bottom. However, researcher has considered that the third design was the best. Third design uses horizontal blades and has bigger input hole and output hole and also uses handle to simplify in moving machine. The midribs entering from above and will be cut by blades which is driven by engine. The rotation of machine will be transmission through belting and pulley. Design 2D and 3D of chopper machine can be seen in figure 2 and 3.

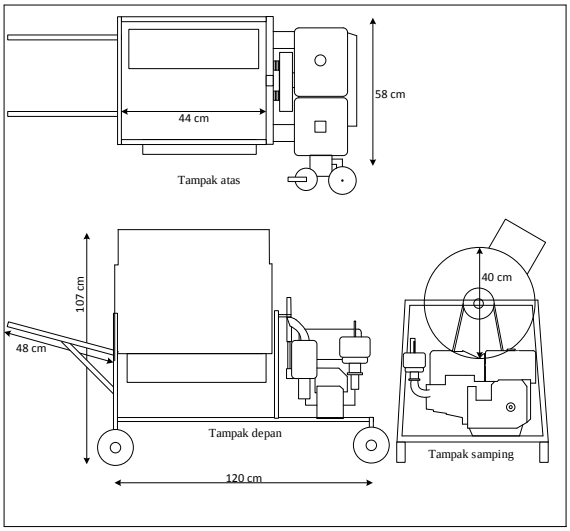

Figure 2. Design of Chopper Machine in 2 D

In order to see the 3 D machine. It can be seen in figure 3 below.

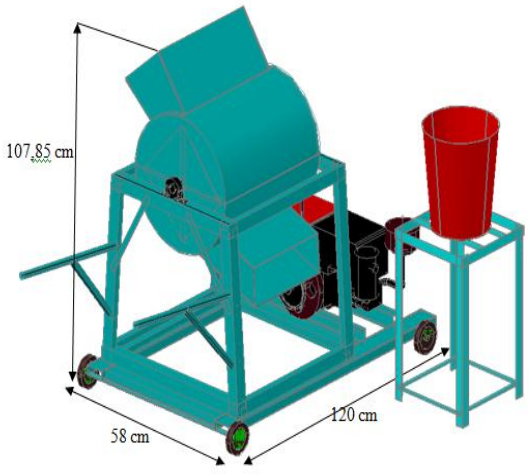

Figure 3. Model 3D Chopper Machine
Source : Data Processing 2015

C. Raw material cost

Raw material costs are the cost of components purchasing to construct the chopper machine for palm oil midribs. The details of raw material costs can be seen in table 3 below.

Table 3. Raw Material Costs

No	Item	Price per item	Amount	Total
1	Bearing 1"	50000	2	100000
2	Pulley with 4 slot	100000	2	200000
3	Belting B 30"	40000	2	80000
4	Wheel 6"	87500	4	350000
5	Iron Putty	40000	1	40000
6	Paint	60000	1	60000
7	Thinner	30000	1	30000
8	Bolt-Nut	40000	1	40000
9	Electrode	100000	1	100000
10	Plat 1,8 mm	1000000	1	1000000
11	Diesel engine	1800000	1	1800000
12	Profil U 2"	300000	1	300000
13	Elbow 40	150000	2	300000
14	Axle	160000	1	160000
15	Fusel	20000	2	40000
16	Blades	50000	4	200000
Total				4,800,000

D. Cost of manufacture

Costs of manufacture are the cost needed to pay all services of manufacturing in the workshop. The details of manufacture costs are described in the table 4 below.

Table 4. Manufacture costs

No	Type	Usage	Rental Machine (/ Hour)	Cost Operator	Total
1	Welding	15	35000	300000	825000
2	Lathe	3	70000	170000	380000
3	Drilling	2	30000	125000	185000
4	Grinding	2	35000	125000	195000
5	Hardening	2	70000	100000	240000
6	Finishing	4	25000	75000	175000
Total					2.000.000

Cost Idea

The costs of idea of a design is determined by the designer, It is Rp. 200.000.

Total Cost of Manufacture

Finally, Total cost that is required for whole design are:

Total cost = Raw material cost + Manufacture cost + Cost of idea (6)

Total cost = 4,800,000 + 2,000,000 + 200,000 = 7,000,000

E. Testing of machine performance

This test aims to know the performances of machine. It has been tested by chopping the midrib for several times during 3 minutes. Midribs used are midribs without and with leaves. The result of test could be seen in table 5 below.

Table 5. Engineering Test Results

No	Time	With Leaf sheaths (gr)	Without Leaf sheaths (gr)	Specification
1	16.00 - 16.03	2740	-	
2	16.05 - 16.08	2550	-	
3	16.12 - 16.15	2970	-	
4	16.20 - 16.23	-	1600	
5	16.27 - 16.30	-	1450	
6	16.34 - 16.37	-	1550	
Average		2753	1533	

Test had been conducted on Saturday, 15 August 2015 at 16.00 pm in Sekolah Tinggi Teknologi, Dumai. Test had been run for six times where each trial for three minutes. Machine chopped three times for midribs with leaf and also three times for midribs without leaf. Midribs were taken from around Sekolah Tinggi Teknologi Dumai.

4. Conclusion

The conclusions that can be drawn from this research are:

Design of chopper machine for palm oil midribs uses antropometri approach and had obtained a final design with 107.85 cm for height and 120 cm for length and 58 cm for width. However, standing was a chosen position to operate because was intended to be easily moved or changed during chopped process. Machine is operated by 1 worker with or without special skill. Finally, this research had produced an effective and ergonomic

chopper machine for palm oil midribs with four very sharp blades and can be operated effectively since had been designed with ergonomics approach.

Suggestion

For further development, there are four suggestions that can be given.

1. The blades of machine and cover of drum should use corrosion resistance materials because blades are exposed by fluids from midribs and will be easy becoming corrosion that will affect the quality.
2. In order to simplify of machine, starter can be seriously developed so that when turning on the machine does not need to crank that is spending a lot of energy.
3. The framework can be designed by using solid and heavy materials to reduce vibrations.
4. Safety cover should be made to cover belting to avoid accident.

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