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Analysis Of Time Motion Study Comparison For Coconut Husk Processing With Coconut Husk Crushing Machine Assistive Tool

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Abstract
Background. Entrepreneurs utilize abundant raw materials by making coconut husk, which is the main ingredient in making coconut husk brooms. However, many still use conventional methods to process it, such as pounding it until it becomes fiber.
Aim. To be carried out effectively, it is deemed necessary to have technological assistance, such as the Coconut Husk Shredding Machine.
Methods. However, to ensure that the aid has improved the effectiveness of the coconut husk shredding process, it is necessary to analyze and compare the time motion study between the two methods. By comparing the Standard Time between the two methods,
Result. We can determine the extent of the difference, allowing us to quickly estimate the amount of product produced from coconut husk shredding within a specific time frame or how long it takes to process the available amount of coconut husk.
Conclusion. The research and time motion study analysis results in an activity of shredding coconut husks using conventional methods and machines, which aligns with the hypothesis that shredding coconut husks using machines is 2.91 minutes faster than traditional methods.
Implication. This work time measurement recommendation can be used as a standard time measurement in shredding coconut husks using conventional and machine methods.

Keywords: Chopper, Machine, Coconut, Fiber, Time Motion Study.

INTRODUCTION

The dynamics of technology are growing and developing rapidly, in line with the progress of modern times that prioritize practical, multifunctional, and economical technology. The creation of new products in various fields marks this.

In particular, in agriculture, which is one of the leading sectors and the livelihood of most of the Indonesian population, it is necessary to develop tools that can support the improvement of agricultural production, both during the pre-harvest and post-harvest periods.

Indonesia is the largest coconut producer in the world, with 18.3 million tons per year. Coconut coir is a byproduct and constitutes the most significant part of the coconut fruit, accounting for about 35 percent of the fruit's weight. Thus, approximately 6.4 million tons of coconut husk waste are produced and not yet utilized.

Some people throw away and consider coconut husks waste, but they actually have additional value that is very useful for the benefit of all humanity. Raw coconut husk may only have a few uses, but processed and transformed coconut husk may have many more.

With abundant raw materials, entrepreneurs utilize coconut husks as the primary material in the production process of coconut husk brooms. However, many still use conventional methods, such as pounding them until they become frayed. This method is very ineffective because the long processing time produces subpar products. Therefore, to maximize and develop products from coconut coir fibers, an ideal working method is needed not to hinder the production process. With the principles and techniques of optimal work method arrangement in the work system, alternative work implementation methods will be obtained that are considered to yield the most effective and efficient results.

Therefore, the author intends to take the research title "Comparison Analysis of Time Motion Study on Coconut Fiber Chopping Work with the Aid of a Coconut Fiber Chopping Machine."

Motion and time study examines the movements that constitute a task. This study is conducted to reduce the number of movements made to complete a task, increasing productivity at work. The motion and time study focuses on observing each movement element that constitutes a job. In that observation, two types of studies can be used: visual motion study and micromotion study. The difference between these two types of studies lies in the tools used to observe the object of observation. In the visual motion study, the recording is done by directly observing the observed object. In contrast, in the micro motion study, the observation is conducted with the help of a recording device in the form of a camera with constant speed, which makes it easier for the observer to divide each work element. Therefore, a micromotion study is suitable for repeatedly performing at high speeds.

LITERATURE REVIEW

Coconut

The coconut is a plant indigenous to tropical regions, specifically places situated along the equator. Numerous coconut palms thrive and are farmed across the tropical regions of Patani. In Indonesia, it is present in nearly all provinces, ranging from low coastal regions to more elevated mountainous locations. In densely populated regions, such as Java and Bali, coconut trees are predominantly cultivated in moorland or residential yards, whereas in sparsely populated regions, like transmigration areas, coconut trees are primarily grown on extensive tracts of land utilizing a monoculture plantation system. The coconut plant is a multifaceted species. Nearly all plant components are utilizable for human existence. Coconut trees yield food and beverages, industrial products, building materials, household appliances, and more (Khalid, 2024).

A consequence of the coconut component is that coconut shells can be utilized as shell charcoal. The composition of coconuts indicates that mature coconut fruits contain 359 calories per 100 grams, semi-mature coconut meat contains 180 calories per 100 grams, and young coconut meat includes 68 calories per 100 grams. The typical caloric content of coconut water is approximately 17 calories per 100 grams. Green coconut water, in comparison to other varieties of coconut water, possesses the highest concentration of tannins or anti-toxins. The makeup of other primary chemical components consists of enzymes capable of decomposing toxins, whereas the chemical constituents of coconut water include vitamin C, protein, fat, carbohydrates, calcium, and potassium.

Traditional dehusking of coconut is time-consuming, not effective, not economical, and a difficult process, coupled with the high cost of importing previously developed dehusking machines. This work aims to create a coconut de-husker that is affordable, user-friendly, and highly productive. Consideration was given to the three main varieties available in Nigeria: West African tall, hybrid, and dwarf green varieties. All materials selected for the construction were locally sourced. The machine consists of two rollers of mild steel with spikes, shafts, an electric motor, spur gears, block bearings, and a mild-steel frame (Olorunfemi, 2022).

Coconut shells constitute a prevalent form of solid waste due to their frequent disposal by the coconut industry. Furthermore, they are a sustainable resource that is environmentally beneficial and safe. Utilizing waste material will decrease the expenses associated with alternative resources. Chemical substances. Coconut shells can be employed as coconut shell powder, serving as a potential solution for coconut disposal and an alternative for enhancing asphalt qualities (Kevindran, 2016). Coconut is an important plant in Thailand's economy. Coconut is a perennial plant. Characteristics of feather-like compound leaves. It consists of an outer shell, coconut fiber and coconut shell (Tongdang, 2023).

METHOD

Research methods are a framework for problem-solving that briefly describes the stages of problem resolution along with their explanations. In general, research methods are designed to achieve the predetermined research objectives. Therefore, the research activities are designed to follow the flowchart as shown in Figure 3.1. The research method consists of the following stages:

1. Problem Identification

The problem identified in this research is due to the abundant raw materials and very long processing time during the shredding of coconut husks because traditional tools are still being used. Therefore, creating a Coconut Husk Shredding Machine and conducting a Time and Motion Study analysis is necessary.

2. Research Objectives

The purpose of this research is to determine the standard working time by considering the system's effectiveness and which method is better, traditional tools or a coconut husk shredding machine.

3. Literature Study

Literature Study is a series of activities related to collecting library data, reading and taking notes, and managing research materials. The activities carried out at this stage include: scientific articles, scientific journals, and books related to the topic, as well as discussions with the supervising lecturer.

4. Data Collection Techniques

The collection of data required for this research was obtained through:

a) Field observation

An activity conducted through direct observation of the working conditions in the small and medium-sized enterprise (SME) producing brooms, then recorded to obtain the necessary data for the research.

b) Interview

An activity or direct question-and-answer interaction with certain parties in a department related to the object of the problem being studied.

c) Documentation

Conducted through data collection and studying documents and company records related to the object being researched.

d) Measurements

The measurement in this study was conducted by measuring time using a stopwatch on a work element.

Data collection is carried out to obtain the information needed in order to achieve the research objectives. The data used is qualitative and employs methods such as interviews, observations, and literature review.

DISCUSSION

Calculation of Standard Time in the Time and Motion Study Method

In determining the standard time for an activity, we must first calculate the observation time in a coconut husk shredding activity using either the manual method or the machine method. The table below is an observation table with 20 observations for each coconut husk shredding method.

Table 1. Coconut husk shredding time

Data ke	X	X_2	Data ke	X	X_2
1	1,55	0,22	11	1,57	0,15
2	1,52	0,20	12	1,53	0,17
3	2,02	0,21	13	1,56	0,16
4	2,05	0,22	14	1,59	0,15
5	2,00	0,22	15	1,54	0,14
6	1,50	0,18	16	2,01	0,19
7	1,58	0,17	17	1,58	0,21
8	2,10	0,18	18	2,00	0,23
9	2,03	0,16	19	2,03	0,18
10	2,01	0,20	20	2,04	0,22
jumlah X	35,81				
Jumlah X_2	3,76				

Source: Research Data

Where:

Data X = Time taken to shred coconut husks using conventional methods

Data X2 = Time taken to shred coconut husk with a machine

Calculating Cycle Time The cycle time for the activity of processing coconut husks from collecting the husks to becoming coir fiber can be calculated using the formula below:

$$Ws = \frac{\sum x}{N}$$

Where:

Ws : Cycle time

X : Observation time

N : number of observations

Therefore:

In the process of manually shredding coconut husks:

$$Ws = \frac{2331}{20} = 117\ seconds\ or\ 1{,}95\ minute$$

Meanwhile, in the process of shredding coconut husks with a machine:

$$Ws = \frac{376}{20} = 19\ seconds\ or\ 0{,}32\ minute$$

Uniformity Test

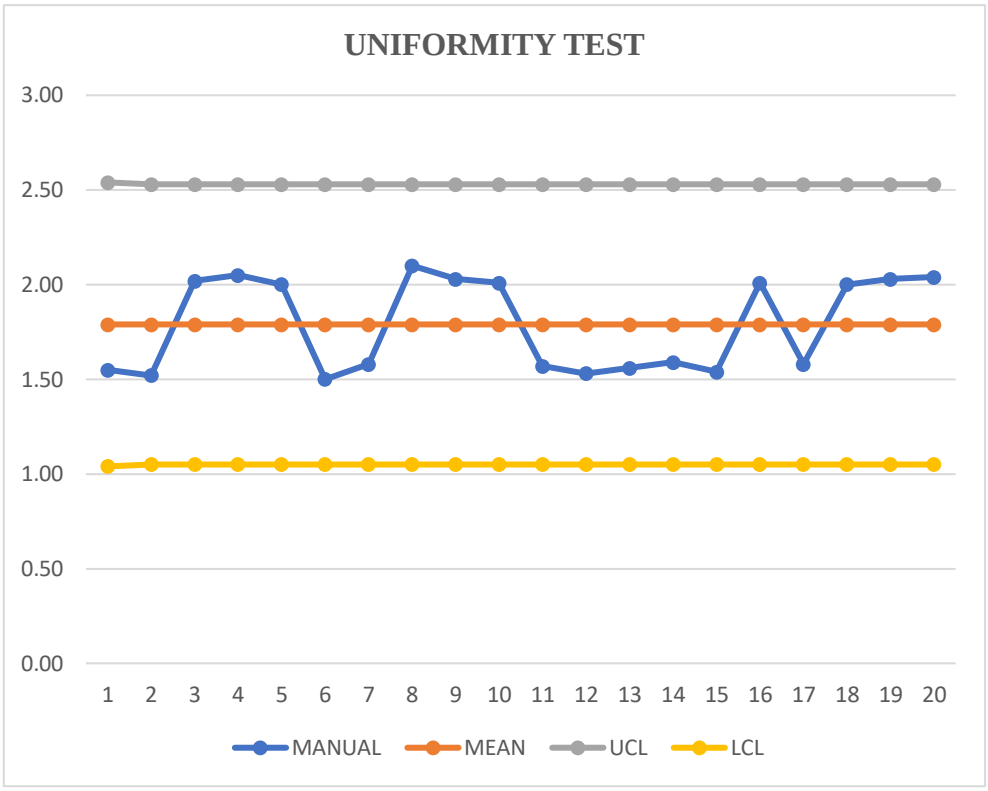
From the data that has been collected, the calculation is continued to determine the UCL (Upper Control Limit) and LCL (Lower Control Limit) values to prove that the average observation data lies between the UCL and LCL.

UCL = $\bar{X}$ + 3 × sd
= 1,95 + 3 × 0.25
= 2,7 (Conventional)

LCL = $\bar{X}$ − 3 × sd
= 1,95 − 3 × 0.25
= 1.20 (Conventional)

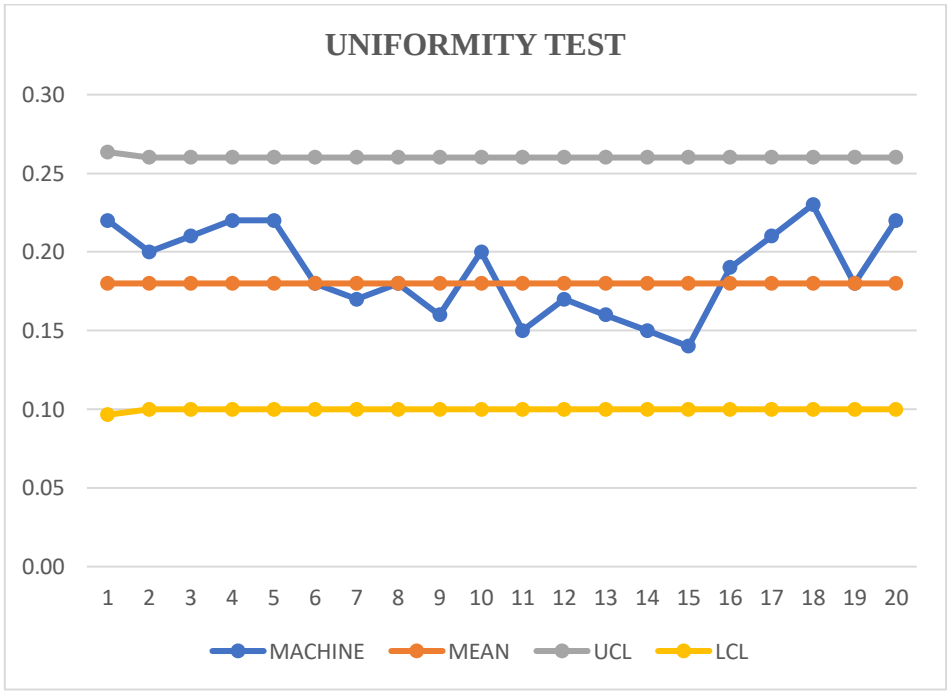
UCL = $\bar{X}$ + 3 × sd
= 0,32 + 3 × 0.03
= 0,41 (Machine)

LCL = $\bar{X}$ − 3 × sd
= 0,32 − 3 × 0.03
= 0,23 (Machine)



Source: Research Data

Figure 1. Uniformity test diagram for the manual method



Source: Research Data

Figure 2. Data uniformity test diagram for the machine method

Work adjustment factors

Table. 2 Classes in the Schumard Method

Class	Adjustment
Superfast	100
Fast +	95
Fast	90
Fast -	85
Excellent	80
Good +	75
Good	70
Good -	65
Normal	60
Fair +	55
Fair	50
Fair -	45
Poor	40

Source: Schumard Method.

To determine the adjustment factor value using the Schumard method class, the formula is as follows:

P = Adjustment value/60

Therefore:

P = 80/60 = 1.33

Normal time calculation

The normal time for the activity of shredding coconut husks is given by the formula:

Wn = Ws x p

Therefore:

Wn = 1.95 x 1.33 = 2.59 minutes process manually

Wn = 0.32 x 1.33 = 0.43 minutes for the process using the machine

Flexibility Factor

The factor of looseness in the coconut husk shredding activity can be seen in the table below:

Table. 3 Manual Method Flexibility

Manual Method Flexibility			
No.	Factor	Info	Flexibility (%)
1	Force needed	Swinging a hammer (light)	7.5
2	Body placement	Sitting (light sitting work)	0.5
3	Work motion	Limited	3
4	Eyes tiredness	Meticulous	6
5	Workplace temperature	Normal	2
6	Atmosphere condition	Not well, a little smelly	2
7	Good environment condition	Work cycle between 5-10	1
8	Inevitable obstacles	1) Wringing water	4
		2) Peeling the skin of coconut husk	
Total Flexibility			26

Source: Research Data

Table. 4 Machine Method Flexibility

Manual Method Flexibility			
No.	Factor	Info	Flexibility (%)
1	Force needed	No force needed	4
2	Body placement	Sitting (light sitting work)	0.5
3	Work motion	Normal	0
4	Eyes tiredness	Meticulous	6
5	Workplace temperature	Normal	2
6	Atmosphere condition	Dusty	5
7	Good environment condition	Very noisy	4.5
8	Inevitable obstacles	Sweeping cocopeat and dust	4
Total Flexibility			26

Source: Research Data

Standard Time

The standard time of manual method coconut shredding could be calculated using the formula:

$$Wb = Wn\ x\ \frac{100\%}{100\% - L\%}$$

Where:

Wb = Standard time

Wn = Normal time

L = Flexibility

Therefore:

Wb = 2,59 $x\ \frac{100\%}{100\%-26\%}$

Wb = 2,59 $x\ \frac{100\%}{74\%}$

Wb = 2,59 x 1,35

Wb = 3,49 Minutes (Using manual method)

Wb = 0,43 x $\frac{100\%}{100\%-26\%}$

Wb = 0,43 x $\frac{100\%}{74\%}$

Wb = 0,43 x 1,35

Wb = 0,58 Minute (Using machine method)

CONCLUSION

The results of the research and time motion study analysis of shredding coconut husk using conventional methods and machines are in line with the hypothesis that shredding coconut husk using machines is 2.91 minutes faster compared to conventional methods.

Table 5. Conclusion of the Analysis

No.	Analysis	Manual	Machine
1	Observation conducted	20	20
2	Cycle time	1.95	0.32
3	Adjustment factor value	1.33	1.33
4	Normal time	2.59	0.43
5	Flexible time	26%	26%
6	Standard time	3.49	0.58

Source: Research Data

IMPLICATION

This work time measurement recommendation can be used as a standard time measurement for shredding coconut husks using both conventional and machine methods.

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