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Design and Build a Cassava Peeling Machine to Increase Productivity

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ABSTRACT

Cassava (Manihotesculenta) is an agricultural commodity widely used to meet various human needs and increase production. Cassava peeling requires technological improvements, including the peeling process. The L-shaped iron, which is shaped at a right angle, functions as a blade that will rotate and slice the material's surface continuously along with the rotation of the peeling cylinder. This research stage includes functional, structural, and testing approaches. The test parameters on the machine prototype are material mass, percentage of damage due to stripping, rate of unpeeled skin, and stripping efficiency. The smallest weight value and the one with the most significant weight value have a large difference in power value, namely 5.83 Watts. This occurs due to the large voltage and electric current deals, which initially peeling cassava with a diameter of 48 mm were only 4.49 volts and 3.3 amperes, which increased when peeling cassava weighing 52 mm. The current value required was 4.8 volts and 4.3 amperes.

Keywords: Cassava, Peeling Machine, VDI 2222 Method

INTRODUCTION

This research was conducted in a business making cassava chip snacks in Surabaya. The first stage is cassava stripping; the cassava is separated from the skin at this stage [1]. This separation system uses a second-hand knife; the right hand holds the cassava, and the left-hand holds the knife. The paring knife is moved horizontally; the second stage is the cassava display. At this stage, the show uses an electric machine with a horizontal blade, which uses employees to hold cassava [2]. The third stage is purification, where the display results are put together in a bucket containing clean water. The fourth stage is frying, where washed cassava is immediately fried [3].

Problems in the stripping process where the tools used by employees to peel cassava are still traditional or manual, the stripping process makes the work slow because the stripping time can take about 2 hours to get 30 kg of cassava with employees working on 1 person. This process takes a long time because you have to take one cassava after another. One hand holds the cassava, and the other peels the cassava with a tool. The target achieved in manufacturing must reach 120 kg with approximately 6 hours of work. However, workers can only complete 90 kg of stripping within 6 hours using a manual peeler. The problem of stripping that does not reach this target will hurt the company in terms of time and sales.

Observations were also made regarding worker complaints by distributing questionnaires to identify workers' complaints when peeling cassava skin with a manual peeler. Complaints are experienced, such as shoulder pain, arm pain, and elbow pain. This complaint is caused by the work position that forms a right-hand angle of 90 degrees with repetitive Horizontal movements. Accidents are injuries to workers' hands due to high levels of fatigue. Other body pains in the shoulder, dislocation, and potential dangers are frozen shoulders and osteoarthritis (swelling of the joint in the shoulder).

The benefit of automatic equipment is that it reduces production costs and costs incurred by employees, and production capacity can be further increased [4]. The machine is created automatically and is portable. To ease an employee's work, a cassava chip peeler is needed to make cassava chips [5]. Based on the reasons and analysis of the problem, it is necessary to design a cassava chip peeler that can reduce the level of elasticity in employees and increase the yield of production capacity. This cassava chip peeling machine is made as efficiently as possible for home industry use [6]. This designed tool can mainly be used for peeling cassava skin. Based on the benefits and problems above, the cassava skin peeling system is essential in writing the final project. It is expected to be one form of solution [7].

The VDI 2222 method is a systematic design approach to formulating and directing various design methods increasingly developing due to activities [8]–[12]. This method is still relevant because it is by the current product manufacturing process flow or manufacturing process model determined by design. At this design stage, there is a relationship between processes, where the subsequent design process depends on the results of process assessments carried out from several construction alternatives[13]–[17]. Each available choice is evaluated to determine the other options to use. The evaluation is given on several aspects, namely technical and economic [18]–[21].

METHOD

Data Collection Techniques

1. Primary data

This data collection is done by observing the cassava skin-stripping process and conducting candid interviews with employees. The processing time is data obtained through direct observation in the field. This data was collected by directly observing the time of the cassava skin peeling process in making cassava chips [22]–[24].

2. Secondary data

This data is a recapitulation and documentation data on making cassava chips.

Data Processing Techniques

1. Tool Design

This design stage is based on detailed working drawings used as information materials, designing or assembling tools, and determining the type of material and parts used. The material specifications used in the design of cassava skin peelers include materials, dimensions, and system use functions. The frame specification uses solid iron, pipes, and plates in the primary frame circuit and uses V-belt components, pulleys, dynamos, wheels, axle shafts, spindles, and tires. The flow in completing the work design is carried out with several general stages, namely [25]–[28]:

a. Measurement of solid iron, plate, and pipe
b. Cutting of measured material
c. Assembly on the main frame and roll line mount assembly
d. Body of dynamo mount, iron roll Axle shaft, spindle, wheel, pulley.
e. Measurement of handle material
f. Handle assembly
g. Wheel mounting
h. Combining part components and designs that have been made

2. Tool Testing

Testing stages of cassava chips. At the test stage of this tool, observations were made in cassava peeling activities in making cassava chips and observing again the amount of time achieved compared to the time of the previous stage process.

RESULTS AND DISCUSSION

Overall Function Structure

This stage is carried out by dividing functions on the cassava skin stripping machine to find alternatives and solve problems with these functions. The overall operation of the cassava peeling machine is to peel cassava skin with a process that can cleanse the skin.

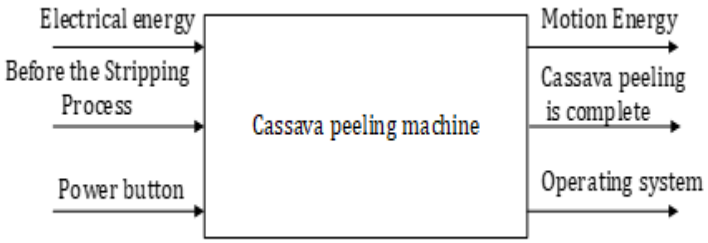


Figure 1. Black Box Sketch

The working principle of the propel shaft engine is that when the button to start the machine is turned on, the drive source will turn on and give output in the form of rotation from an electric motor channeled through a pulley transmission element, including the pull shaft. This towing shaft's function is to break the prayer rug, which rotates to touch the prayer mat through a two-way rotation of the two posts. The part of this elastic knife that peels cassava skin through cassava rotation with the concept of stripping following the shape of cassava. This process continually runs through the pusher shaft that rotates the cassava and is directly connected to the stripping process.

Table 1. Alternative Parts Functions

Criterion	Alternative I	Alternative II	Alternative III
Drive Source Function	AC Electric Motor	DC Electric Motor	Gasoline Motorcycle
Propel Shaft Function	Holo Iron Pusher Shaft	Hydraulic propellant shaft	Jagged Propel Shaft
Rotation Shaft Function	Two shaft rotates	One Shaft player	One Shaft Turner

Functions of the blade	Two Cylinder	Semicircle	Circular
Output Track Function	Iron Plate	Spring	Towing path

1. Alternative Engine Drive Function

Table 2. Cassava Peeler Machine Drive Options

Alternative 1	**Alternative 2**	**Alternative 3**
		
AC Electric Motor	DC Electric Motor	Gasoline Motorcycle
Excess: -Great Power -No slip -Low Price Deficiency: -Speed is not easy to control - Low power factor at light loads	Excess: -Easy controls -Low Price Deficiency: -Relatively small power -Not durable	Excess: - Power uses petrol Deficiency: - Louder sound -Expensive price -Maintenance is difficult

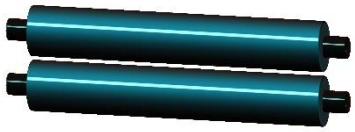
2. Alternative Function of the Propeller Shaft

Table 3. Cassava Peeler Machine Pusher Selection

Alternative 1	**Alternative 2**	**Alternative 3**
		
Solid Iron Shaft	**Shaft of hydraulic**	**Jagged Shaft**
Excess: -Not Easy to Crack and durable Deficiency: -Still using encouragement from humans	Excess: -Move Yourself Deficiency: -Prolonged movement -Complicated working system -Difficult Engine Repair System	Excess: -Jagged shaft surface is more quickly rusty Deficiency: -The machining process of making gear shafts is difficult -Difficulty of advanced machining process of making gear shafts

3. Shaft Rotater Function

Table 4. Alternative Functions of Shaft Rotater

Alternative 1	Alternative 2	Alternative 3
		
Two Rotating Shafts	**One Rotating Shaft**	**Jagged Shaft**
Excess: 1. Easy *part* machining process	Excess: 1. Easy part machining process shaft rotation against cassava is solid and elastic	Excess: 1. The surface of the shaft is serrated so that it is capable of posting in its appearance
Deficiency: 1. Stripping processes are complex and very long. 2. Must clean the dirt around the shaft	Deficiency: 1. The frictional force caused by the large iron is easily eroded	Deficiency: 1. Heavy loads 2. The machining process of making gear shafts is difficult 3. Difficulty of advanced machining shafts of gear shaft manufacturing

Determination of Overall Concept Variance

Assessment is conducted to select alternative overall functions that will be further developed in the product design phase. The evaluation will provide aspects that are or are not worthy of a design concept in a technical part and economic elements in the distribution of questionnaires to closed.

Table 5. Variance Aspects of Technical and Economical Concepts

Aspects assessed	Alternative 1	Alternative 2	Alternative 3	Value Ideal
Construction	4	5	5	14
Machine Ease	2	3	2	7
Tool Precision	2	3	3	8
Kumudah Assembly	4	5	5	14
Handlers	2	5	3	10
Maintenance costs	2	5	3	10
Cost of manufacture	2	5	3	10
Total Value	18	31	24	73
Percentage	24.6 %	42.4 %	28.7 %	100%

Based on the questionnaire and the results in Table 2, the ideal combination function is the alternative overall function of the 2nd alternative. It is assessed from the technical and economic aspects and has the best value with a total value of 31 and 42.4% financial.

Design

Alternative assessment of concept variations is assessed based on technical and economic aspects. Based on these two aspects, alternative interpretations of Concept 2 were chosen. Cassava skin stripping design uses one shaft as a drive to rotate cassava. The semicircular blade mechanism can peel cassava evenly as an exit path shift utilizing a spring attached to the push lever. The overall concept of the cassava skin removal plan is in Figure 3.

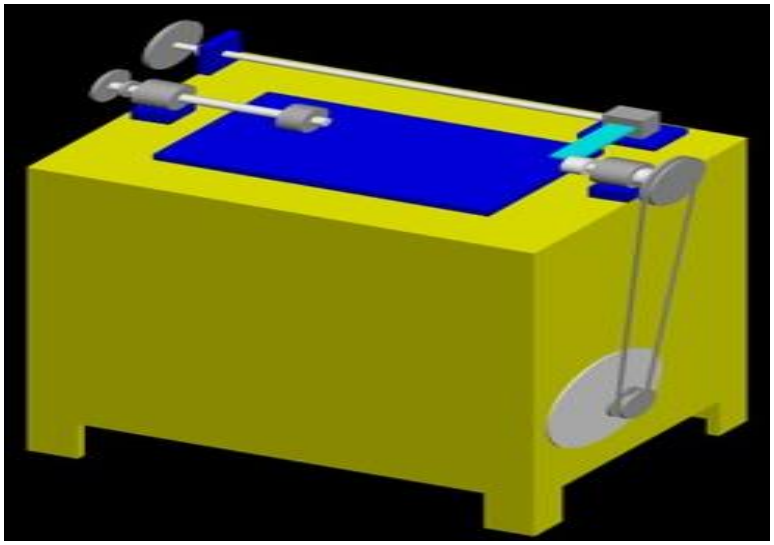


Figure 2. Cassava Stripping Design

A holo iron frame is cut to a length of 40 cm, 50 cm high, and 30 cm wide, and then, after cutting, the iron is welded to form a square. Weld the iron plate pieces that have been cut into pieces for dynamo DC 1 Hp position and fuse the Gaer box.

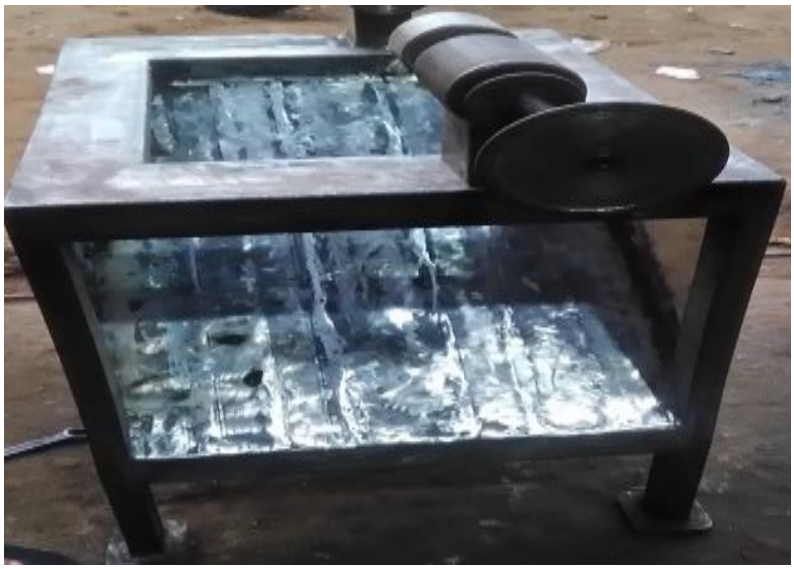


Figure 3. Cassava Peeling Machine frame manufacturing

Stages of the cutting process using a cutting machine (cutting grinding machine) on holo iron measuring 40 cm long, 50 cm high, and 30 cm wide, the second stage of the welding process on table position iron, the position of the dynamo machine, and the part of the bearing stem. In the third stage, solid iron turns for the inner bearing position and turns the skin so that the length and size of the cassava can be adjusted.

Assembly Process of All Part Components

Mastering this tool is straightforward for workers to use, where the cassava process is taken one by one and placed vertically next to the blade. The machine will rotate the cassava in the same direction, and later, the edge will move backward slowly, and the cassava skin will peel off the whole. The cassava that has been peeled off the skin will be exchanged for cassava that has not been peeled off the skin, and the blade will move back forward while peeling the cassava skin and the cassava skin has been peeled off all in this case, reducing complaints of pain felt in the left shoulder 40% and left shoulder 20%. And reduce the rate of accidents, namely injuries to workers due to high fatigue and negligence from the workers. And making the way of working will be slow and take much production time that is getting longer. And make production meet its production level. With tools that are made as light and easy as how they work here, we can save production costs and production time without having to reduce the production target itself. This tool still uses human assistance, like placing raw materials and moving the blade in the same direction so the cassava skin is peeled. When the cassava eyes are pushed backward, the cassava skin has all peeled off, and when the cassava eyes are in the forward movement, the cassava skin has peeled off, too. Here, we do not need to rotate the cassava manually like we use a manual tool. Here, the cassava has been turned using a machine, so the device that will rotate the cassava only helps the movement backward and forward. The speed of movement on and backward depends on the worker's energy, and here, there is no need to spend a lot of energy because once pushed back, the cassava skin has been peeled off without us having to do a good movement. Repetitive, like a manual tool.

Tool Testing

After conducting a series of processes in making cassava peelers with the basic principles of lathes, tool testing will be carried out to see whether or not the tool is feasible. Here are some tests for cassava skin peelers with the basic principles of lathes. The first step is to weigh the mass of the material by 5 kg. Then, measure the diameter and length of cassava to find out the surface area of the material. Right at the time of the stripping process.

Based on the characteristics of cassava, which consists of three layers of skin, namely brownish outer skin, inner skin layer ranging from 1-3 mm, and cassava meat, which has the most significant percentage. From the calculation of the cutting depth of cassava in the first sample, we can explain that cassava is perfectly peeled with a depth of 3 mm. That is, the cassava peeler works perfectly.

Figure 5. Cassava Before peeling and after peeling

Table 6. Cassava Peeling Machine Power Test Results

Testing To-	Cassava Diameter(mm)	Speed Rotation (RPM)	Voltage (Volts)	Current (Amperes)	Power (Watts)	Energy (Wh)
1	48	322	4.49	3.3	14.81	2.96
2	56	526	4.51	3.5	15.78	3.15
3	51	412	4.53	3.8	17.21	5.45
4	50	200	4.56	3.9	17.78	5.04
5	45	288	4.7	4.1	19.27	8.03
6	50	203	4.71	4.1	19.55	4.88
7	60	196	4.72	4.2	19.82	3.96
8	50	545	4.73	4.2	20.33	7.45
9	52	323	4.8	4.3	20.64	4.81
10	40	194	4.46	3.9	19.07	4.98

From the measurement results, the cassava stripping process with the smallest weight value and the one with the most significant weight value has a large enough power value difference of 5.83 Watts. This occurs due to the substantial value of voltage and electric current, which was initially in the process of peeling cassava diameter 48 mm only to 4.49 volts and 3.3 amperes, increased in peeling cassava weighing 52 mm the current value needed is 4.8 volts and 4.3 amperes.

DISCUSSION

The efficiency process before using design tools when carrying out the stripping process where the tools used by employees to peel cassava are very manual. This makes work slow because the stripping time can take about 2 hours to get 30 kg of cassava. Employees working on there is 1 employee Automatic Cassava Peeling and Slicing Machines able to help workers avoid the risk of work accidents MSDs and make more effective use of time in processing. This research aims to design and manufacture automatic cassava peeling and slicing machines [6]. This research produces automatic cassava peeling and cutting machines with specifications measuring 75 cm x 75 cm x 100 cm, using LED sensors, devices with a capacity of 10 kg, engine age of 5 years, the thickness of slicing

blades of 1 mm, cylindrical peeling knives [29]. The research found an engine capacity of 4.8 kg/minute from the 1400 rpm blade shaft rotation connected to a 2 HP electric motor with a shredded blade diameter of 13 cm and a length of 33 cm. The engine size is 797 x 606 x 822 (LxWxH), resulting in an engine weight without a product of 18 kg. Grated cassava should measure 5 cm in diameter with a length of 15 cm. The importance of one cassava is 0.993 kg [30].

The efficiency process after using design tools when carrying out the stripping process where the tools used by employees to peel cassava using this machine work fast because the stripping time takes about 2 hours to get 40 kg of cassava with employees working on 1 employee. This process does not take time because you must take cassava individually, which is placed into a tool screening using a machine. In stripping cassava skin, which weighs 920 grams, for 14 minutes, 4.81 watt hours of electrical power are needed. This value has increased compared to the operation of stripping cassava skin, which weighs 758 grams for 12 minutes and only requires 3.96 watts per hour [31]. After testing this tool, it can produce more sweet potato production, which is 15,398 kg/hour, than manual stripping, which can only produce 10 kg/hour. So, the development of cassava peeling machines was designed to increase the productivity of cassava skin stripping.

CONCLUSION

Part of the working system rotates the blade using a series of blades. The function of the screw is as a tool for moving the knife blade with human help so that the cassava skin can be peeled with one movement. The working system detects the flow and changes the movement force found in the human body into a movement flow on the blade, which is lighter so that the power produced is sufficient to move the knife blade. So, there are not many injuries to the hands because the eye movement is placed on the side of the cassava, which is helped to rotate by the direction of the machine. The results of tests that have been carried out on cassava show that production levels can increase in 1 hour, and the entire system and parts can work well, but there is a time lag when we do the peeling. We have to change the size of the cassava by resetting the size by turning the screw. -adjust the size of the cassava to be peeled. The smallest weight value and the one with the most significant weight value have a relatively large difference in power value, namely 5.83 Watts. This occurs due to the large voltage and electric current deals, which initially peeling cassava with a diameter of 48 mm were only 4.49 volts and 3.3 amperes, which increased when peeling cassava weighing 52 mm. The current value required was 4.8 volts and 4.3 amperes.

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