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Conceptual design of dual purpose coconut dehusking machine

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ABSTRACT

Coconut dehusking is one of the procedures that take numbers of time and efforts. Mostly they involve human labour with the help of manual tools that made from steel or wood crowbar. However, most of them, only focus to dehusk only the coconut. Therefore, the objective of this paper is to determine the conceptual designs of dual operating dehusking machine. This paper discusses similar methods and compares the final design of other dehusking machine. There were three conceptual designs been analysed in term of design matrix and discussed in details this paper. The result showed that third design is chosen as a final design due more practicality and lower cost to be fabricated. It can be concluded that the selected final design meets the requirement of the criteria that have been stated.



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Introduction

The coconut tree is named 'Thousand-use tree', since in many respects any part of the tree is useful. Coconut is also used in the manufacture of oil, cosmetics, medicines, coconut milk processing, and other added value products (Sivapragasam, 2008). Manual husking is time consuming because it is done by hand using sharp edge steel tools either a crowbar or a machete. In fact, it is risky and may give the workers serious back pain. In addition, the agricultural labor shortage is crucial (Akhir et al., 2016). The introduction of a mechanical dehusking device is therefore useful for solving such problems. Both techniques require skilled labor and are inefficient in their application. Attempts made so far in the production of dehusking tools were only moderately efficient in replacing manual methods, and not reliable.

Grated coconut is consumed for culinary preparation either extracted into coconut milk, fresh grated coconut flesh or turn it into powder. In South-East Asia, grated coconut usually used for gravy dishes such as "Masak Lemak Cili Padi", "Rendang" and "Sayur Lodeh" for example. Also grated coconut used in preparing dessert like "Ondeh-Ondeh", "Kuih Lapis" and "Kuih Kasui". Mostly grated coconut is processed from matured coconut kernel or flesh before it is can be used for cooking or making a dessert. Meantime, processing grated coconut kernel is time consuming and tedious. There has been no modification in the way coconut is grated, for several decades (Raj R, Raj, & N, 2016).

Combination of coconut dehusking and grating machine currently is very fewer in market. It is necessary to design a machine that can perform dual tasks for household used. This dual purpose machine can be used in household or small industry due to compact design and portable. Therefore, the main objectives of this paper is to choose a conceptual design that will be used to create a prototype of machine. Choosing the correct methods, tools and equipments are prior for this conceptual design. To begin with, firstly identifies the dehusking process and grating process that suitable for designing a compact machine. There are various techniques or method widely used to dehusk coconut but with their own limitation (Gaikwad, Bagadi, Kamble, Gadakari, & Burase, 2017). Some of the methods are manual operated coconut dehusker and machine operated coconut dehusker. For manual operated coconut dehusker, either using the foot pedal, hand or both. Whilst, for machine operated coconut dehusker there are semi-auto dehusker, hydraulic dehusker, pneumatic dehusker and fully automated dehusker.

The grating process of coconut kernel also divides into two types of method, either manual process or machine process. Throughout household use, the coconut grater is operated manually (Markose & Gopalkrishnan, 1996). Manual process for grating coconut usually used a spike grater tools. Coconut grating machine process either use a rotational grater cone or cylindrical grater. However, both of the processes need an operator to operate manually or control the machine. In Table 1 and Table 2 below, shows various methods for dehusking and grating coconut.

Table 1 <Types Of Dehusking Method>

Method of Operation	Description
1. Manual	
a. Machete	Use bare hand to remove the husk from coconut with machete or knife.
b. Spear (Hand)	Use a steel spike or wood crowbar to remove the husk. A mechanism operate by hand.
c. Spear (Foot)	Use a steel spike and attach a mechanism that operate using foot.
2. Machine	
a. Hydraulic	A hydraulic cylinder is attach to levers. These levers remove the husk in one stroke.
b. Pneumatic	A pneumatic cylinder is attach to lever that press the coconut to a fix tools.
c. Mechanical	Two roller attach with spikes is rotate inward to remove the husk.
d. Rotary	Coconut is insert into a circle steel frame. A rotary tool remove the husk.

Table 2 <Types of Grating Method>

Method	Description
1. Manual	
a. Traditional Hand Grater	Coconut was grated using hand to a spike plate attached to a stool.
b. Rotary Hand Grater	A rotary grater operate using hand.
2. Machine	
a. Rotary Grater	A grater was mounted to a electric motor. Coconut is grating by hand to grater.
b. Cylindrical Grater	A roller grater run using motor and coconut kernels are pour into the machine.

According to both tables above, each of methods are suitable in difference type of environment, from household tools to large capacity production. The conceptual design of machine that going to propose is can be suit for household and small scale production. This is main limitation of the conceptual design. Another limitations for conceptual design to be consider are list below;

- i. The design should be small in size.
- ii. The design should be portable.
- iii. The design should be ease to use.
- iv. The design should consider low human effort and safety.
- v. The design should combine two process in one machine.

Method

The development of dehusking and grating machine begin with the idea on how to create a machine that economic, can process large amount of coconut, low human effort and reduce operating time (Jacob & Rajesh, 2012)(S.D et al., 2020)(Akhir et al., 2016)(Aje & Ogbeche, 2019)(Navaneethan, Prasath, Pradeep, Santhana Prabhu, & Palanivelrajan, 2020). The conceptual design of dual purpose machine is to understand how the process work. This step is to make sure every single process are not been neglected since it is prior to conduct an idea generation.

A similar design has been presented known as multipurpose machine. This multipurpose machine has three operations namely as dehusking, cutting and grating coconut (Bhatia, Arora, Arora, & Manchanda, 2019). Their design consisted of a pulley in which the mechanism for the motion of the cylinder with sprockets are presented. The coconut will be inserted into the sprocket grooves to be dehusked in between. After that, it is moved to the cutter where it performs the process of cutting the coconut into halves. Next, if the coconut water is needed, then the machine consists of a punch to remove the water. The coconut is then moved to the grater for grating and can be further used in the food products for preparation.

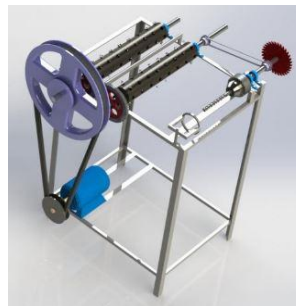


Figure 1 <Design of Coconut De-Husker, Cutter and Grater Machine (Bhatia et al., 2019)>

Conceptual Design

In this phase, several concept design of dual purpose dehusking coconut machine will be proposed. The concept design is using different type of mechanism for dehusker and. Both of operations can be done simultaneously. Two person can operate the machine without disturbing each other because the tools are installed adjacently. The machine is can be located to any flat surface.

Conceptual Design 1

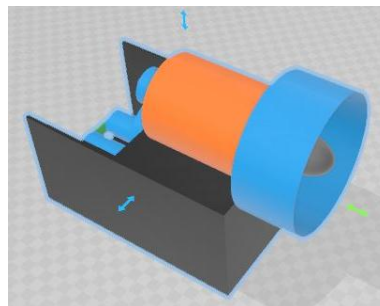


Figure 2 <Conceptual Design 1>

This machine is using spiked rollers to remove coconut husk and an electrical grater to grate the coconut. The rollers attached to same electrical motor that turn the grater. Double shaft motor will be used to run both of tasks. A set of reducing gears is applied between the rollers and the shaft to reduce the speed of rollers eventhough the motor turning a grater at the same time. When operating the machine, spiked rollers will turn inward direction to push out the husk below. Then, the coconut been cut into halves. Next, the coconut is been grated to rotating grater to finish the task. Both of operation need a protective gloves to avoid injury during operating the machine.

Concept Design 2.

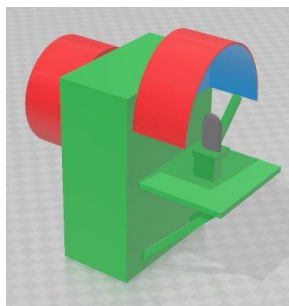


Figure 3 <Conceptual Design 2>

This machine is using a manual spike with hinged mechanism to remove coconut husk and an electrical grater to grate the coconut. A single shaft electrical motor is used to turn the grater. When operating the machine, an operator take a coconut and press it toward a spike. Then, pull down a lever that attach to hinged spike to remove husk. This task been repeated several time until the husk completely been removed. Then, the coconut been cut into halves. Next, the coconut is been grated to rotating grater to finish the task. Both of operation need a protective gloves to avoid injury during operating the machine.

Conceptual Design 3

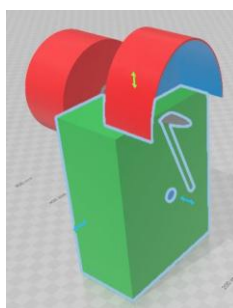


Figure 4 <Conceptual Design 3>

This machine is using a spike with hinged mechanism to remove coconut husk and an electrical grater to grate the coconut. The hinged spike been attached to same electrical motor that turn the grater. Double shaft motor will be used to run both of tasks. A lever mechanism attached to the hinged part of spike. When operating the machine, an operator take a coconut and press it toward a spike. Then, hinged spike pull the husk down. This task been repeated several time until the husk completely been removed. Then, the coconut been cut into halves. Next, the coconut is been grated to rotating grater to finish the task. Both of operation need a protective gloves to avoid injury during operating the machine.

Table 4 <Design Matrix>

Criteria	Conceptual Design 1	Conceptual Design 2	Conceptual Design 3
Performance	3	2	2
Size/weight	1	2	3
Affordable	2	3	2
Aesthetics	2	2	3
Material/Ease of Production	2	3	3
Ease of Use	2	2	3
Safety	2	2	3
Total score	14	16	19

oring keys : 1 – Low, 2 – Medium, 3 - High

Results and Discussion

In this paper, a concept design for dual purpose coconut dehusking machine. Three conceptual design have been proposed to be choose as final conceptual design. The final conceptual design will be redrawn in detail for further fabrication and material selection. A prototype of the machine will be created and tested.

For first conceptual design, both operation run simultaneously but in different speed of rotation. Rotation speed for dehusking may lower than the grating operation due to attached a set of gear reducer for dehusker parts. However, parts of dehusker may results large in size for whole machine. The spiked rollers been

assembled in a box shaped design with a shielded lids. In fact, during dehusking operation, the coconut will be rotated by rollers. The machine need to be stopped to take out the dehusked coconut for every single time. This will disturbed the grating operation and it is time consuming if a large amount of coconut need to be dehusked.

In second conceptual design, the grating operation may have no major problem at all because, manual dehusker tools is attached to the machine thar require no electricity. However it is a bit time consuming for dehusking operation. The operator use their effort to tear out the husk using hinged lever by hand for several times until the coconut shell can be pull out. It is consume a large of human energy that will be ended with tiredness and fatigue. Even the whole size may be smaller than first conceptual design, but it does not meet the design limitation which is reducing human fatigue.

Third conceptual design, both dehusking and grating operation are run simultaneously. Double shaft motor is but with different speed of operaton. In dehusking part, the use of hinged spike allowing the size of machine been decreased. Human effort is use to press in the coconut toward the spike. The hinged spike tear off the husk downward assist by a lever that attach to motor. Between the lever and the motor, there is a gear reducer and a plate to pull the lever. Dehusking operation been done in several time with minimal use of human energy. Then, grating operation remains the same for each conceptual design. An additional device shall be invented to hold the coconut shell during grating operation. This will prevent injury for human when using the machine for grating the coconut.

As a result, the third conceptual design been choosen because it is meet the limitation requirement. Whilst, further research and development of dual purpose dehusking machine need to be done in order to get the better design. Every single parts of machine will be recreate and redesign. At the end, a prototype of the machine can be released.

Conclusions

To conclude with, a final design of dual purpose dehusking machine have been decided in this paper. The selection of third conceptual design shall be ended with a prototype of machine. Several research and development work need to be done for further task. This will intoduced to community with a new product that may help them dealing with coconut dehusking and grating operation. Although it is not a high level technology product, but it is commonly used around the world. There are so many types of machine been invented but the innovation still come with new ideas. Therefore, the creation of this dual purpose coconut dehusking machine just a part of innovation to help the human being.

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