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To Design a Semi-Auto Coconut Peeling Machine

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Abstract: The design of a semi-automatic coconut peeling machine was successfully produced and implemented with the assistance and guidance of George E. Dieter's design technique. Throughout the design process, conclusions are drawn from the findings and presented to the client. Research and numerous start-ups culminated in developing a semi-automatic coconut peeling machine to peel coconuts, which met the project's objectives in full. This design has been thoroughly researched to demonstrate that it can meet all of the product's specifications. Based on theoretical calculations, it is projected that the daily production rate is 220 coconuts daily. The machine weighs an overall total of 186.932 kg and consumes an overall total of 40.149 watts. Following that, to achieve the project's goal, the use of SolidWorks had been improved during the project's development. The three basic mechanics employed in this machine's construction are side peeling, top peeling, and bottom cutting. Each of these mechanisms works in concert with the others to make a more efficient machine design possible by coordinating their operations. Finally, this project can assist coconut-based Small and Medium-Sized Enterprises (SME) in their everyday operations by peeling the coconut following their selling requirements.

Keywords: Coconut, Side Peeling Mechanism, Top Peeling Mechanism, Bottom Cutting Mechanism, Solidworks

1. Introduction

In Malaysia, there are high demands of young coconut products, mostly its water. There are also a few other food products that can be produced by using this young coconut such as Coconut Jelly and Coconut Ice-Cream. Recently, the seller takes the initiative by creating the new product base from young coconut such as coconut shake.

Because of the high demands for the product of young coconut, the seller needs to prepare a vast number of young coconuts to support the market. The seller needs to minimize the time taken to peel the young coconut and increase the number of peeled young coconut at a specific time. The safety of the seller must be put in prioritize during the peeling process.

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Usually, the seller uses the traditional method to prepare the young coconut. They use a special sharp knife to peel the young coconut. In terms of safety, there is a higher chance for the seller to get the injury while using a sharp knife. The peeler needs to have high coconut peeling skills to minimize injury chances. By using the traditional method also, it takes a longer time to peel the young coconut for the preparation.

Figure 1: Special Sharp Knife for Young Coconut

In the new era of technologies globalization, the method of young coconut peeling had been improvised. There are a few technologies that have been created to help the young coconut peeling process. The shape of the knife had been changed to make the blade sharper during the peeling process. The engineers also had produced some of the new machines to help minimize the time taken during the peeling process.

Although the previous researcher had promoted the new mechanism, there are a few problems that need to be solved. The young coconut seller or requestor of this project study faces the difficulty of carrying out the problem in the peeling process. The young coconut cannot be peel as what it should be peel off. The water hard to be taken if the customer uses this machine to peel the young coconut. It can be said the current peeler is not suitable for the job. Thus, another alternative has to be generated.

As a result, a portable and affordable young coconut peeler must be developed to replace the current peeler machine and the traditional method use by the seller. In short, the new technologies of young coconut peeling machine is necessary to solve the problem face by the young coconut seller.

1.1 Objective

The objective of this project is as follows:

1. To develop the design of a semi-auto coconut peeling machine that can help to increase the daily output percentage by Small to Medium Enterprise (SME) entrepreneurs.
2. To design of coconut peeling machine by using software SolidWorks.
3. To measure the safety level between the traditional method of peeling coconut by using a peeling knife and conventional method of peeling coconut by using semi-auto coconut peeling machine.

2. Literature Review

A literature review is necessary to assess pertinent material on connected themes in order to ascertain knowledge about the machine's design structure, working mechanism, and requirements for this project. It was accomplished using a patent search and benchmarking process.

2.1 Study on Patents

Patent search is done through “Free Patent Search” and “Google Patent” to gather information for machine specifications in this project. Five patents are selected and discussed in this section.

2.2 Study on Available Products

Existing goods available on the market are consumer products. The quest for commercial interests is needed as it provides information on the details/profiles and features of the current yield on the market that could be useful for the semi-auto coconut peeling machine's product growth. This type of information is necessary because it displays and illustrates the semi-auto coconut peeling machine's current features and specifications that are relevant to the real practice that satisfies the current demands, needs and standards. To generate new, novel ideas and establish a more in-depth understanding that will lead to a better and sustainable design of the semi-automatic coconut peeling machine during product creation, it is therefore essential to gather information and data about the commercial product available.

3. Methodology

3.1 Design Process Flow Chart

George E. Dieter's engineering design process consists of three phases: problem description, comprehensive design, and the ultimate final product. There are eight phases for puberty, as are seen in Figure 1. There are four primary phases of design, three necessary steps of production, and a single preliminary phase. Every stage of the process is different and essential to solving the design problem. Some of these phases are important for a solution to be effective in solving the issue at hand. Each stage below will be discussed in depth.

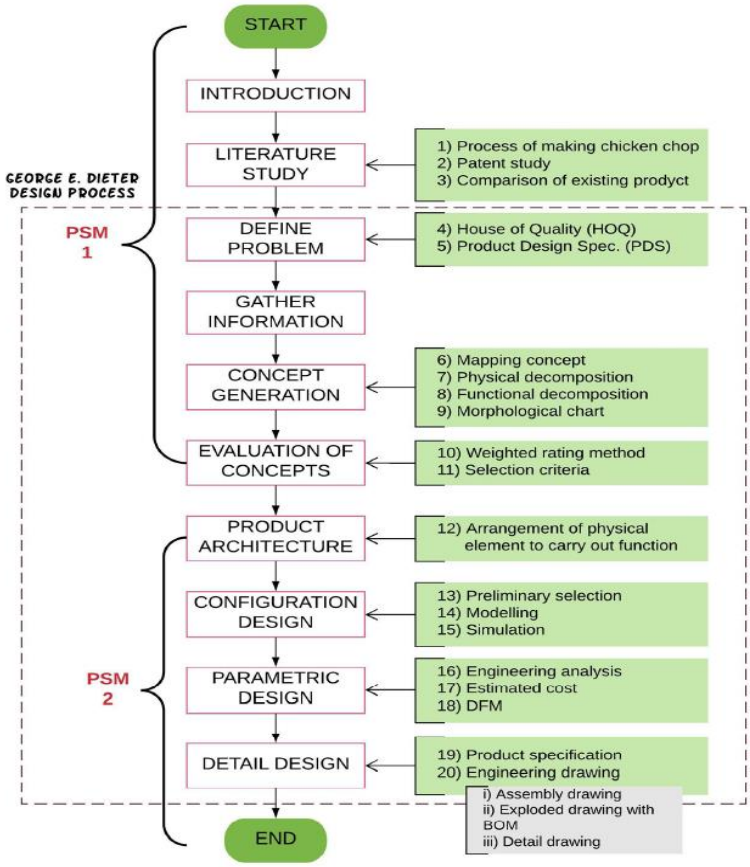

Figure 1: Flow Chart of the Design Process

In this first section, a consumer need is identified. When a need or desire is established, a problem statement is formulated. The aim is to establish an idea that most accurately represents the problem area and the solutions that will meet its needs or wants (Dieter & C.Schmidt, 2016). The issue must be well

understood and described in a clearly expressed and intelligible manner before continuing with the rest of the analysis(*9780133439274 - Engineering Economy by Elin M. Wicks, C.Patrick Koelling William G. Sullivan*, n.d.).

Errors in the description would result in the wrong solutions to the defined problems. It requires considering different factors such as target requirements, limitations, trade-offs and competing goods to help formulate a solution (Dieter & C.Schmidt, 2016). It must also be specified in terms of organizational and technical requirements about Quality Feature Deployment (QFD). QFD is a suitable method for connecting customer needs with design specifications, which will be used in later sections to assess a semi-auto coconut peeling machine's technical and operational aspects.

The next step in a design process is reviewing the literature for a report, which will form the basis for analysing literature in this project. Information can be translated through several sources, including books, catalogues, patents, handbooks, and consumer reviews (Dieter & C.Schmidt, 2016). Any material about peeling machine such as its classification, ranking, protection, construction, parts, and other information is gathered to help develop the characteristics and features of a semi-auto coconut peeling machine.

At this stage, a wide range of approaches to solving the problem are discussed. This phase consists of a definition mapping, physical decomposition, and visual representation of the structure (Dieter & C.Schmidt, 2016). Concept Mapping (CM) offers a creative way of creating ideas by brainstorming. Brainstorming is a useful tool for finding the best solution to a problem or question (*Brainstorm | Definition of Brainstorm by Merriam-Webster*, n.d.). On the one side, physical decomposition requires analysing the semi-auto coconut peeling machine sections and components in a hierarchical structure. The chart shows several options for how each component can be organised to form a specific definition.

At this point, feedback is given on the proposed concepts. Many assessment tools can be used to judge definitions such as the Pugh Map, Weighted Decision Matrix, and Evaluation Matrix (Dieter & C.Schmidt, 2016). I use a weighted decision matrix to pick the best idea in the project and refine it further. In summary, the selection and decision-making process occurs at this point.

Sizing the product architecture is the first step to designing the software framework. The issue involves the integration and modularity of the various components of the semi-automatic coconut peeling machine. It refers to the arrangement and functional design of physical elements and parts and how they come together to construct something (George E. Dieter, 2009).

Parametric design is the final compilation stage in the initialization design process (Dieter & C.Schmidt, 2016). It addresses the sizing and sizing procedures of all components of a coconut peeling system. All measurements for each element are defined. Both parts have output tolerances in the design. The design must be consistent with environmental objectives such as waste reduction and sustainable disposal by recyclability. Besides, based on each material's total weight, the cost of the simple semi-auto coconut peeling machine will be determined.

The final stage of a design process is product engineering design. Information Design refers to the finalized detailing drawings and specifications. All are detailing the design of the semi-auto coconut peeling system will be drawn using SolidWorks. The detailed drawing should show the assembly drawing followed by the exploded view drawing, and the detail sections. All the parts are built and sized with the same dimensions. The product specification was derived from the parametric design, and are correct. Based on the finalized product design specification, the resulting product would satisfy the customer's requirements.

If the design work is completed, it is ready for prototyping. Many steps are taken when the procedure is developed, and a list of all operations is completed (Dieter & C.Schmidt, 2016). We measured and determined the expense. The product's disability and retirement are also considered to ensure the design exhibits sustainability and geared toward green engineering such as using recyclable content. A prototype is made, and its success or failure will be evaluated against several trials.

3.2 Product Design Specification

The goal tree, house of quality (HOQ), and product design specification (PDS) are created using the client needs survey information. The HOQ results indicate that engineering features are given the most significant weight in the project. The objective tree and weighting factor in the objective tree are depicted in Figures 2 and 3, while the HOQ analysis is illustrated in Figures 4.

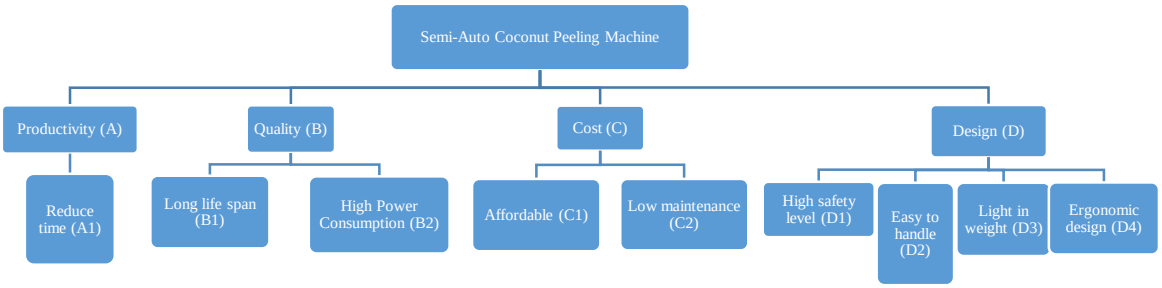

Figure 2: Objective tree according to importance customer requirement.

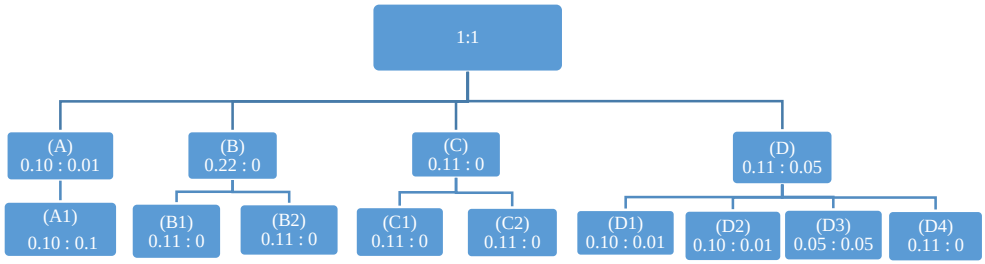

Figure 3: Weighting factor of objective tree

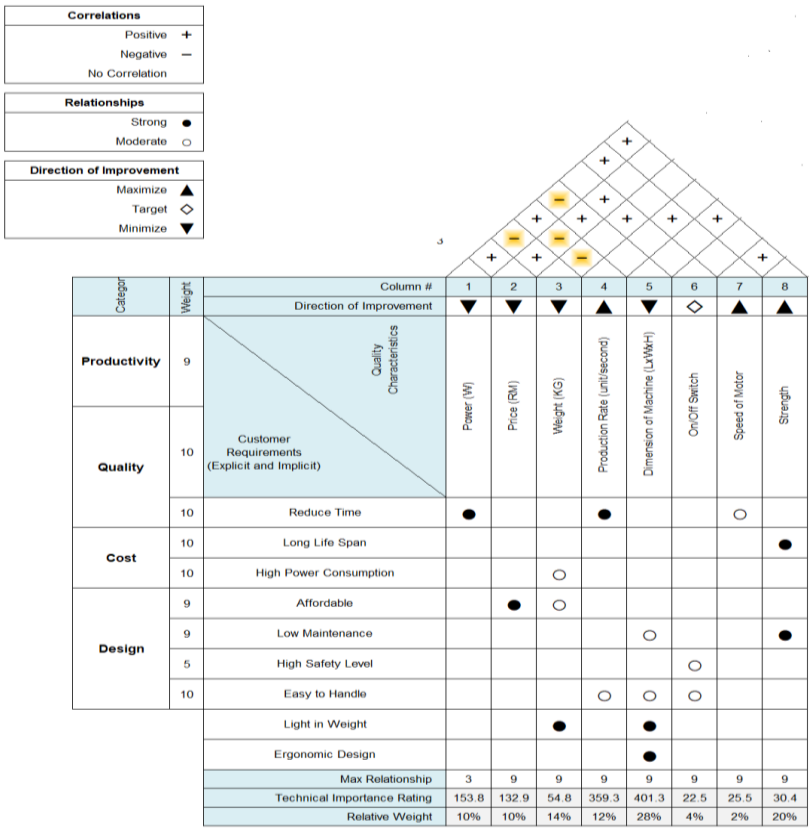

Figure 4: House of Quality (HOQ)

Table 3 Product Design Specification (PDS)

Introduction	
Title: To Design Semi-Auto Coconut Peeling Machine Design Problem: Peeling the coconut Purpose: To peel the coconut Unique Feature: Semi-auto machine, efficiently and faster in peeling the coconut	
Customer Needs	
Performance function	- Can peel 1 coconut in less than 2 minutes. - Minimum power consumption, under 1 kW.
Operating environment	- Operation is carried out at outside temperature to maintain the freshness of coconut.
Economic	- Should have economic life of more than 5 years. - Should less routine servicing other than cleaning.
Geometric limitation	- Compact size is desired - The machine should less than 1000mm length, width and height.
Maintenance, repair and retirement	- The machine should be easy for cleaning process. - No repair should be required during economic life.
Reliability, robustness	- No failure should occur during economic life. - Will accommodate with water and power supply.
Safety	- Less vibration when use the machine. - Need cover on rotary / conveying mechanism.
Pollution	- Will not create noise >40db.
Human factors	- No large forces or torque required to operate.
Easy to use	- Simple to put the coconut into the peeling space. - Simple on/off switch.

	- Reduce man power, only use 1 person to operate the machine. - Simple to disassemble for cleaning process.
Appearance	- Surface finish should be smooth to facilitate cleaning. - Shape should be consistent with current trends.
Sustainability	- Use a few types of material which can be recycle. - Avoidance of the depletion of natural resources to maintain an ecological balance

3.3 Full Assembly of Semi-Auto Coconut Peeling Machine

After finishing all of the ideas for the sub-assembly, they were merged to form the design for the entire semi-automatic coconut peeling machine. Figure 5 illustrates the isometric perspective of the whole unit by adequately positioning the sub-assembly. Figure 6 illustrates the subassembly in its proper location, complete with a transparent casing. In contrast, Figure 7 depicts an isometric view with simulation.

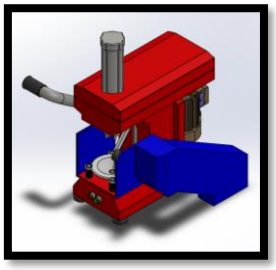

Figure 5: Isometric view with real casing

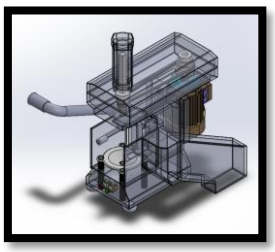

Figure 6: Isometric view with transparent casing

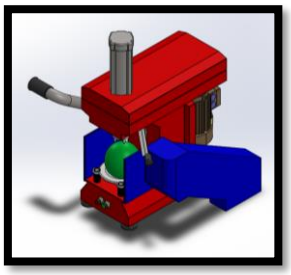

Figure 7: Isometric view with simulation

The feature would be clustered based on the relationship between the product's components and its purpose. The essential functional elements of the product are clustered into groups in Figure 8.

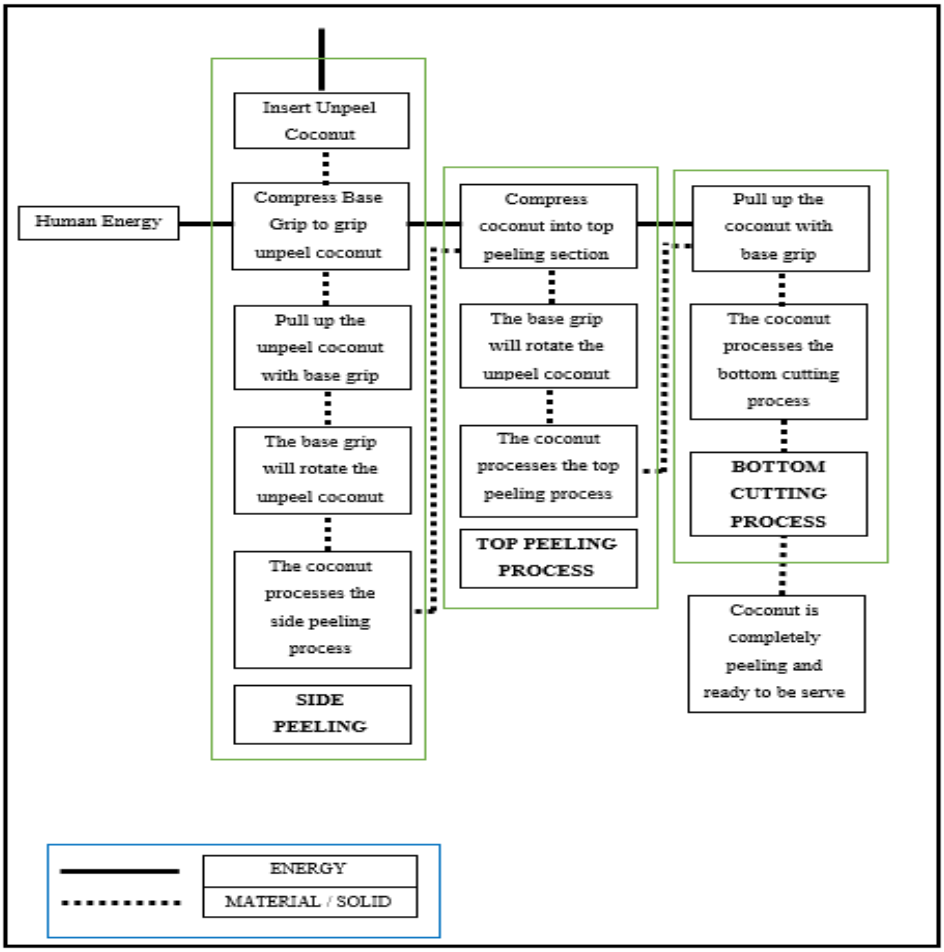

Figure 8: Functional element of product

3.4 Simulation

This segment will simulate the sub-assemblies used on the semi-automatic coconut peeling machine using SolidWorks software. The picture given illustrates the movement of each -mechanism at each sub-assembly. The following sub-assemblies are used in the simulation process:

- Side peeling mechanism
- Top peeling mechanism
- Bottom cutting mechanism

Any of these mechanisms vary according to the requirements of the consumer when peeling the coconut. Before processing, coconuts were usually 179.7 ±5.3 mm in height and 160.2 ± 5.6 mm in diameter. The scale of the coconut before processing is depicted in Figure 9.

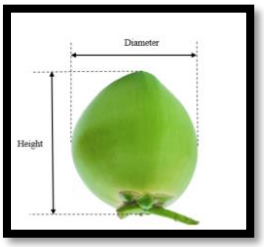

Figure 9: The actual size of coconut before process

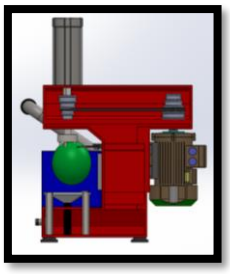

Figure 10: The cross section from side view of the coconut through side peeling mechanism

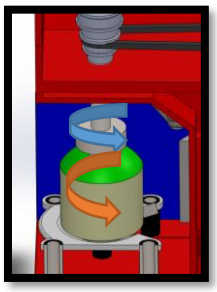

Figure 11: The movement of the top peeling mechanism

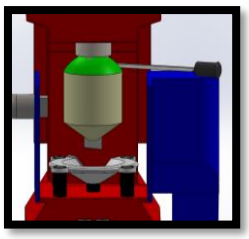

Figure 12: The bottom cutting mechanism for the peeled coconut

3.4 Engineering Analysis

Engineering analysis is used to determine whether or not a critical parameter for a machine part is fulfilled with the machine design. Table 4 illustrates the product design specification for customer information based on the outcome analysis.

Table 4: Product specification

Product Specification	Description
Specification of motor:	
➢ Type of motor	MS561-4 Motor
➢ Power	0.1 kW
➢ Voltage	380 V
➢ Speed	11.46 rpm
Weight of machine	186.932 kg
Dimension	753 mm x 665 mm x 987 mm
Productivity	44 Coconuts / hour
Power consumption	40.149 Watt

3.4 Engineering Drawing

Before the design is released to production, SolidWorks software is used to produce and finalise engineering drawings for the semi-auto coconut peeling machine. Appropriate materials are applied to the machine's component. Figure 13 depicts the mechanism in its entirety.

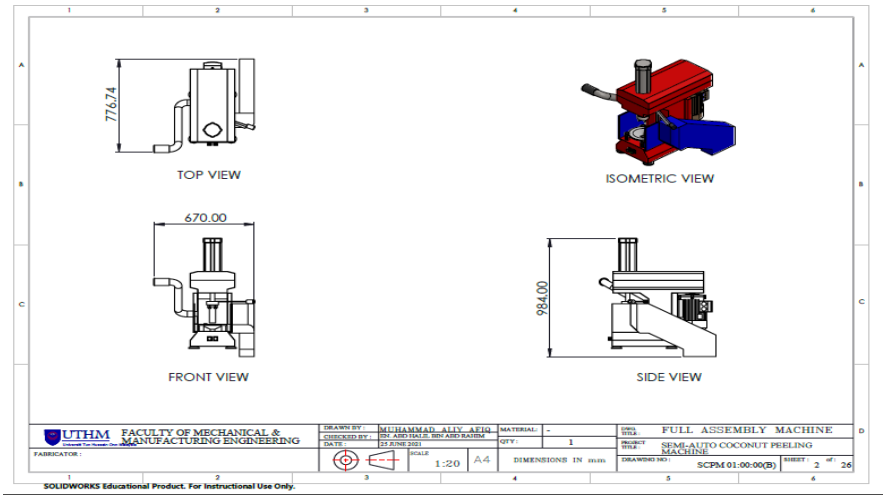

Figure 13: Full assembly of Semi-Auto Coconut Peeling Machine

4. Conclusion

In conclusion, with the assistance and guidance of George E. Dieter's design method, the design of a semi-automatic coconut peeling machine was successfully created and implemented. Throughout the design process, conclusions are formed from the findings. According to the project's objectives, the research and many start-ups resulted in developing a semi-automatic coconut peeling machine for peeling coconuts. This design has been thoroughly investigated to demonstrate that it can meet all of the product's criteria. It is estimated that the daily output rate is 220 coconuts, based on theoretical calculations. The machine weights a total of 186.932 kg and consumes a total of 40.149 watts each day. Next, as the objective of this project, using SolidWorks had been improved in developing the project. Side peeling, top peeling, and bottom cutting are the three primary mechanisms used in constructing this machine. These three mechanisms work together to create a more efficient machine design by coordinating their actions. Finally, this project can help the coconut-based Small Medium Entrepreneurs (SME) in their daily life to peel the coconut-based on their selling demands.

Acknowledgement

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References

[1] *9780133439274 - Engineering Economy by Elin M. Wicks, C.Patrick Koelling William G. Sullivan*. (n.d.). Retrieved January 9, 2021, from https://www.biblio.com/9780133439274

[2] *Brainstorm | Definition of Brainstorm by Merriam-Webster*. (n.d.). Retrieved January 9, 2021, from https://www.merriam-webster.com/dictionary/brainstorm

[3] Dieter, G. E., & C.Schmidt, L. (2016). ENGINEERING DESIGN Fourth Edition. In *IFMBE Proceedings* (Vol. 57). https://doi.org/10.1007/978-3-319-32703-7_118

[4] Abdullah, H., Djamalu, Y., & Botutihe, S. (2016). Pembuatan alat pengupas sabut kelapa muda sistem putar. *Jurnal Teknologi Pertanian Gorontalo*, *1*(2), 183–192.

[5] ENGINEERING, A. (2014). automatic-coconut-trimming-machine.pdf. *Ars Coconuts*.

[6] Hussin, M. H. (2018). Design and development of processing apparatus for young coconuts. *Pertanika Journal of Science and Technology*, *26*(4), 2031–2044.

[7] Jarimopas, B., & Ruttanadat, N. (2007). Development of a young coconut fruit trimming machine. *Journal of Food Engineering*, *79*(3), 752–757. https://doi.org/10.1016/j.jfoodeng.2006.01.082

[8] Jarimopas, Bundit, Ruttanadat, N., & Terdwongworakul, A. (2009). An automatic trimming machine for young coconut fruit. *Biosystems Engineering*, *103*(2), 167–175. https://doi.org/10.1016/j.biosystemseng.2008.10.004

[9] Patel, R. M., Jiang, P., Asplin, J., Granja, I., Capretz, T., Osann, K., Okhunov, Z., Landman, J., & Clayman, R. V. (2018). *Coconut Water : An Unexpected Source of Urinary Citrate*. *2018*.

[10] Phipps, j.B; O'Kennon, R;Lance, R. (1960). The coconut palm. A monograph. *Travel &Tourism Analyst*, *63*(1), 328–331. https://www.cabdirect.org/cabdirect/abstract/19501100562

[11] Saleh, A., Supriono, Suryana, Y., Santoso, A., Ansarullah, Rifaldi3, G., & 1Senior. (n.d.). *DESIGN AND DEVELOPMENT OF YOUNG COCONUT SKIN MACHINERY TO SUPPORT FRESH MARKETING OF FRESH YOUNG COCONUT IN THE STATE AND EXPORT*. 44–48.

[12] Syafriani, R., Sukandar, E. Y., Apriantono, T., & Sigit, J. I. (2014). The Effect of Coconut Water (Cocos Nucifera L.) and an Isotonic Drink on the Change of Heart Rate Frequency in the Rats Induced Hypertension. *Procedia Chemistry*, *13*, 177–180. https://doi.org/10.1016/j.proche.2014.12.023

[13] *V-Belts: What To Know - Insight - Acorn Industrial Services ltd*. (n.d.). Retrieved May 25, 2021, from https://www.acorn-ind.co.uk/insight/v-belts-what-to-know/

[14] Zakaria, Z. A., Ahmad, Z., Somchit, M. N., Arifah, A. K., Khairi, H. M., Sulaiman, M. R., Teh, L. K., Salleh, M. Z., & Long, K. (2010). Antihypercholesterolemia property and fatty acid composition of mardi-produced virgin coconut oils. *African Journal of Pharmacy and Pharmacology*, *4*(9), 636–644.