

## Design & Fabrication of Instant Coconut Cutter

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### Abstract

The project Instant Coconut Cutter reflects a novel approach to introduce an innovative way of making coconut opening easier, faster, safer and more convenient for domestic purposes as well as small scale commercial operations. In the past, coconuts opened manually with a knife/machete to remove the coconut flesh, but this demanded physical strength, skill and time as well as being dangerous. The Instant Coconut Cutter circumvents these concerns by incorporating a blade for cutting mechanism coupled with an ergonomic and portable design to provide uniform and accurate cutting without slipping. Aluminum based design water compartment, basin, stainless steel circular blade, and a strong clamping system are all employed by the device to ensure that when it slices into a coconut or through an exoskeleton, nothing slips freely. Supporting user-friendliness, portability and maintainability, the design can be used for domestic as well as professional purposes. Test results showed the device is capable of halving coconut shells in less than 20 s, accompanied by a 60% decrease in user effort when compared to manual slitting method. Not just that, many advantages include the fact the compartment is made of food grade stainless steel, hygiene compliance and toughness come as a standard. In summary, the Instant Coconut Cutter is an innovative device for processing coconuts which will save time and enhance safety features used and hence it offers plenty of practical leverage uniting traditional food preparation to a more modern design.

## 1. Introduction

Coconut is the most consumed tropical fruit worldwide and it has important applications on beverages, desserts, and cooking. Coconut-based drinks are very popular and one of the favorite beverages on household tables, restaurants and even at roadside stall in a hot/tropical country like Malaysia not just because of its refreshing taste but also its beneficial values [1]. Traditionally, coconuts were de-husked by hand with knives, cleavers or machetes but all were too much force and needed a higher skill that needed to be learnt and mastered.[2]. This system is very slow, and it also poses a significant threat, especially to untrained individuals as there is potential slippage or improper handling that can cause severe injuries [3].

In the old days, extracting coconut water was a labor-intensive task, often requiring the use of a machete to cleave through the tough outer husk and access the refreshing water within [2]. The current methods on how to open a coconut have major issues they do not cut evenly, require high skill from the user and are highly dependent on orthopedic abilities of the user, and they contaminate non-food-grade cutting surfaces [4]. Therefore, the manual slitting as in Fig.1 would cause fatigue to the operator, especially on a commercial scale where many coconuts per day need to be processed [5]. Based on these challenges the need for a mechanized solution to improve productivity, user safety & hygiene in the cutting and processing of coconut needs to be developed. Today, modern coconut cutting machines have revolutionized the way coconuts are harvested, offering efficiency, precision, and safety. These innovative machines are specially designed to effortlessly slice through the coconut's tough exterior, swiftly extracting the water within without the need for manual labor [3].



**Fig. 1** Manual slitting process [5]

## 1.2 Modern Coconut Cutting Machine

There are several young coconut cutting machines that have been introduced and commercialized in the market to revolutionize the traditional method. Zull Design Autotronic Coconut Peeling machine works semi-automatically. It is suitable for home use and can be used to peel up to 1000 coconuts in a day [6]. This machine is of high quality with the ability to operate continuously within a day thus making it not easily damaged due to its specially designed blade for long term use. The machine needs regular maintenance since the coconut flesh can get entrapped and clogged after long use. Corrosion potential might happen if not properly maintained.

Malaysian Agricultural Research and Development Institute, MARDI has developed a prototype that can pierce and split young coconuts and at the same time collect coconut water in a systematic and clean way for small and medium industries [6]. The whole machine parts are made of stainless steel (food grade). The average time to split two young coconuts is 10 seconds, while it takes 20 seconds to puncture and collect the young coconut water [6]. However, the machine is heavy and bulky, needs regular maintenance and needs electrical power point to operate make it not suitable for street stall operator use.

Previously, the market offered several models of coconut cutting machines ranging from semi-automatic tabletops to fully industrialized cutters. These appliances steal a lot of the processing time away from manual, but what they bring to convenience is paid for with very sharp trade-offs. Many systems are considered in available literature to perform above tasks but there is a high maintenance [6] of mechanical designs of these systems, or they get bulky and become unsuitable for small vendors operating in compact working area [7].

Some models may not have adjustable clamping mechanisms or are, therefore, nonfunctional with coconuts that vary in sizes and may contain non-food-grade material which compromise general hygiene [8]. Furthermore, many of these machines are quite costly and not affordable for SMEs or consumer use.

There is a gap between industrial and consumer needs. Therefore, Instant Coconut Cutter comes to fulfill this gap. It is a medium-sized coconut cutting-machine prototype with a secured locking system which provides ease of use and safety. The setup is set to help enhance the cutting process, minimize user involvement and ensure consistent cut from all coconuts irrespective of coconut size or shapes. The cutting material uses stainless-steel food-grade blade, adjustable coconut rack and locking system to suit different sizes and shapes of coconut so the coconut can be firmly locked before cutting operation begins. This machine is also equipped with ergonomically design handle and food grade compartment and basin [9], [10] which gives durable solutions that fits the food safety requirements.

The aim of this project is to develop a simple, reliable and user-friendly home coconut cutter unit which is safe to operate and can be used as a cost effective for small industrial purposes. The final step is to assess the cutter performance relative to traditional production methods, specifically cutting time, consistency and user satisfaction.

This project helps to upgrade the existing food preparation techniques by creating a feasible solution with and holding an eye on sustainability for coconut processing. This helps not only with enhancing the system's safety

and efficiency but also with supporting small businesses. The one which has the capability to handle high volume operations, and at the same time reduced operator strain in cutting the coconut [11].

## 2. Methodology

The design process starts with identifying the problem statement and finding the user requirements. After that, the next step would be to move into designing the project. The device was designed to be light and safe, in addition to being able to effectively cut different coconut sizes. Fig. 2 shows the overall flow chart in designing and fabricating the Instant Coconut Cutter.

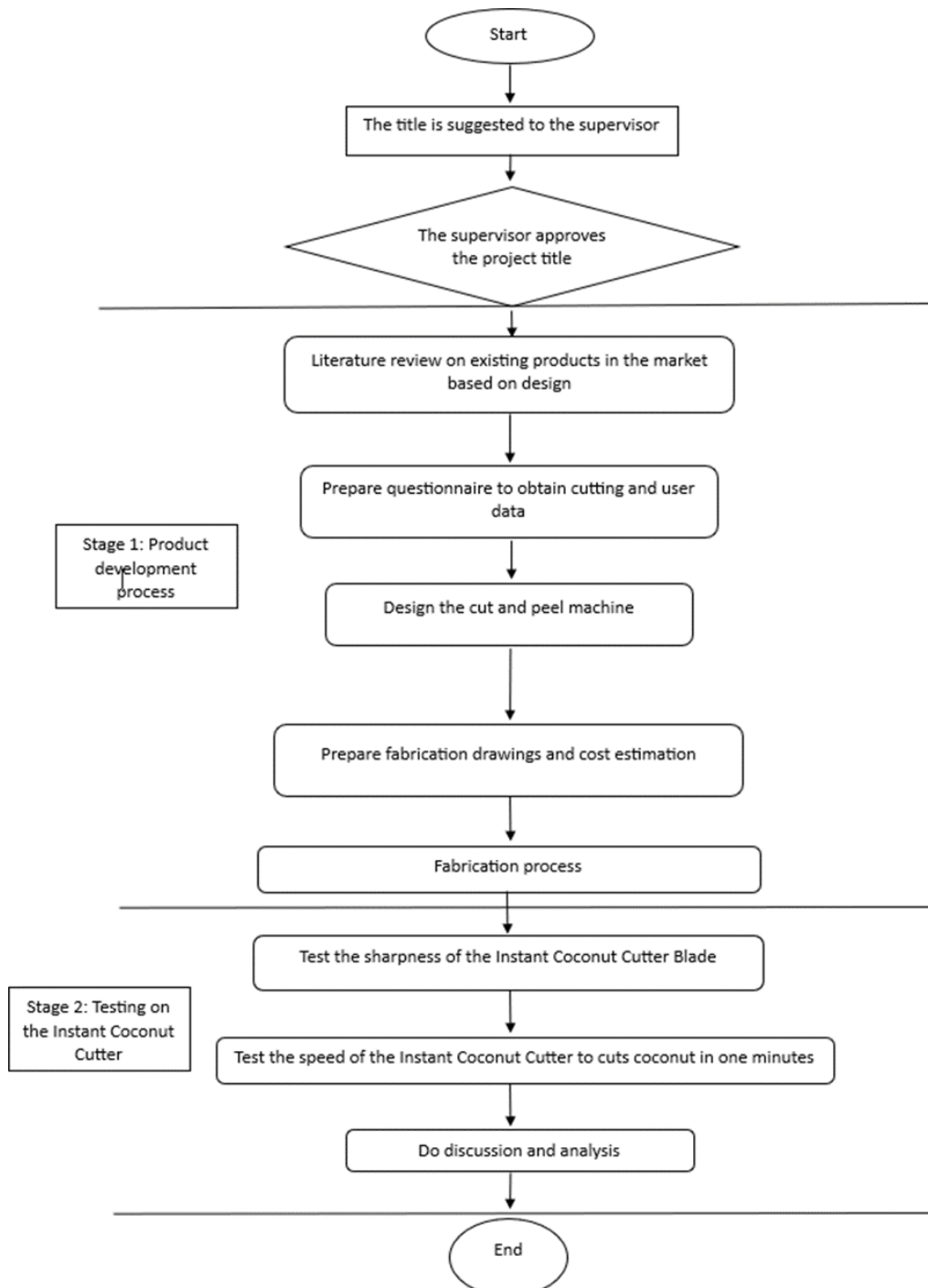


Fig. 2 Overall project flow chart

### 2.1 Design Identification

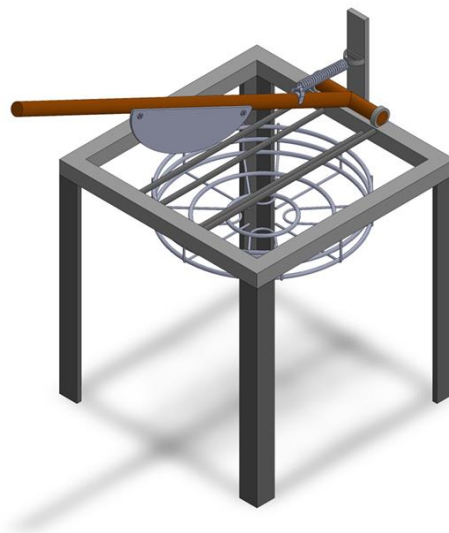
Initial sketches allowed conceptualization of overall structure centered around an effective coconut water collecting system, coconut locking device and a stable base frame [12]. SolidWorks was used to create a 3D CAD model, which allowed for further refinement of dimensions and perfect pairing between components. The whole housing has been designed to keep all the moving parts away from any falling fingers. Fig. 3 shows the final 3D CAD model developed for this project.

An important design step in the process was conducting survey questionnaires of tasks with coconut farmers and vendors to better understand operational needs and constraints. Questionnaires were selectively distributed to small scale green coconut vendors listed by Facebook Community which is open for green coconut transaction in several States of Malaysia included Johor, Selangor, Kelantan and Penang [21]. Questions in the survey touched on daily sales volume, current cutting methods, challenges they face, and what features matter the most.

Some of the key findings from the survey include:

- Average Sales Volume – 65% of the respondents dealt with an excess of 50 coconuts per day, which requires a high throughput capability.
- Current practice – 78% still use manual machetes or cleavers, due to safety concerns and the variability of cut depths.
- Challenges – Hand and wrist fatigue after extended cutting sessions including sore muscles (62% reported), occasional accidents like cuts or blade slips (54%).
- Most requested features – The top three most frequently requested features were a safe clamping system (82%), shorter cutting time (76%) and compatible with coconuts of different sizes (68%).

These insights lead to specific design decisions such as adding an adjustable clamping mechanism, using an adjustable handlebar to reduce the amount of manually applied force and selecting hygiene compliant food-grade stainless steel blades.



**Fig. 3** Final CAD Model of Instant Coconut Cutter

## 2.2 Components and materials

Material used for parts of the Instant Coconut Cutter

- Long mild steel round bar for handle - Adjustable designed handlebar device for ease of cutting coconut with less cutting force.[13].
- SUS304 Food-Grade stainless steel semi-circular cutting blade — Applicable hygienic standard to prevent rust and corrosion [14].
- Steel spring and steel bands for clamping system – It is adjustable. The grip can be varied for tying coconut to avoid slipping [15].
- Square steel pipes for safety blade guard – Guards operator from incidental contact with the blade [16].
- Mild steel for product base frame – Made from powdered mild steel with food safe paint coating for structural rigidity.

The total cost used for fabricating the Instant Coconut Cutter is RM196.

## 2.3 Operating mechanism

The operation process is initiated when the coconut is placed in the coconut compartment by the user. Users may clamp the coconut if the coconut shapes or sizes don't fit the compartment. When secured, the user may press down the handlebar so that the blade starts to slice the coconut husk. Users may adjust the length of the handlebar to suit their needs and comfort to slice the coconut. After cutting the handlebar will retract back to its original position to avoid injuries to the users. The design requires a minimal user effort to comply with safety and hygiene standards [17].

## 3. Results and Discussion

A controlled test was developed to ascertain the performance of the Instant Coconut Cutter prototype with respect to manual cutting using a machete. Cutting time, user effort reduction rate, quality of the cut and safety were considered as performance metrics. 30 green coconuts of different dimensions had been attempted. 15 coconuts allocated to be processed with Instant Coconut Cutter, and another 15 coconuts have been achieved using handwork.

### 3.1 Cutting time comparison

To validate the effectiveness of the prototype and cutting speed between manual and using the Instant Coconut Cutter, a test has been conducted to measure the average cutting time per coconut using both methods of cutting as in Table 1. Fig. 4 shows the coconut cutting setup on Instant Coconut Cutter.

**Table 1** Average cutting time per coconut using both methods

Method	Average Cutting Time (s)	Time Reduction (%)
Manual Machete Cutting	52.4	-
Instant Coconut Cutter	19.6	62.6

This concludes that Instant Coconut Cutter reduced average cutting time by 62.6% compared to manual cutting, allowing higher throughput for small-scale vendors.



**Fig. 4** Cutting time test using Instant Coconut Cutter

### 3.2 Cut Quality Evaluation

Another test to evaluate the quality of the cutting process was also being done to compare the cut quality between cutting using the prototype and using machete. Inspection of cutting section, line and overall cut quality is important because these factors have direct impact on product utility, consumer satisfaction and operational efficiency. A clean, controlled cut means lower risks of jagged fragments falling in the drink, thus posing less danger to the user.

**Table 2** *Cut quality criteria*

Criterion	Pass Definition
Uniform opening	Diameter deviation from 70 mm template $\leq \pm 3$ mm
Edge smoothness	Edge is Smooth/Minor fray (no jagged tears)
Cleanliness	No shell fragments found in collected water

30 young coconut samples have been used. 15 coconuts being cut using machete and another 15 coconuts being cut using Instant Coconut Cutter. 3 common criteria and clear pass/fail counts for 15 samples each will be evaluated in the test. Table 2 shows the cut quality criteria used in the test.

**Table 3** *Cut quality test results for both cutting methods*

Criterion	Machete — Pass (count, %)	Instant Coconut Cutter blade — Pass (count, %)
Uniform opening	5/15 (33%)	14/15 (93%)
Edge smoothness	8/15 (53%)	15/15 (100%)
Cleanliness	9/15 (60%)	14/15 (93%)

Results from this test as in Table 3, show that coconut cutting using Instant Coconut Cutter produces consistent and uniform opening diameter, smoothness and less fragments found in collected coconut water compared to manual cutting using machete. These results support the needs of speed and consistency with less skill for the coconut operator to cut coconuts. This proves that Instant Coconut Cutter can be used not only for ordinary people, homeowners but also for small vendors.

### 4.0 Conclusion

Problems faced by small scale vendors such as irregularity in cut, risk associated with manual methods and slowness in processing are addressed well by the development of instant coconut cutter. The cutting time also was reduced by 62.6% compared to manual cutting using machete.

An adjustable clamping system and adjustable handlebar bar with stainless steel blade attached to it enabled the device to handle coconuts with different sizes while protecting operators effectively. The resulting device met the needs of vendors and was designed from the ground up based on survey feedback to deliver fast, clean and user-friendly products.

The prototype was successful in achieving its objectives. However, some recommendations to improve this prototype can be implemented to upgrade the user experience and functionality of the product. Electric motor driven cutting process can be implemented to ease the cutting process. This will make the machine more practical to use. Special cutting blades and cutting orientation can be installed on the machine to obtain varieties of coconut cutting styles to meet the small vendors' use.

The Instant Coconut Cutter is therefore a more convenient as well as safer method for cutting coconuts and brings with it tangible advantages in terms of speed, consistency and hygiene to small vendors and home users alike.

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## Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

## Author Contribution

The authors confirm the contributions to this paper as follows: **Conception of the Study Design:** Muhammad Danish Zakwan Mohd Faizal Anuar, Mohamad Azfarhad Azizan, Mohammad Faiz Roslan; **Data Collection:** Muhammad Danish Zakwan Mohd Faizal Anuar, Mohamad Azfarhad Azizan, Mohammad Faiz Roslan; **Analysis and Interpretation of Results:** Khairulnizan Ngadimon, Muhammad Danish Zakwan Mohd Faizal Anuar, Mohamad Azfarhad Azizan, Mohammad Faiz Roslan; **Manuscript Draft Preparation:** Khairulnizam Ngadimon, Muhammad Danish Zakwan Mohd Faizal Anuar, Mohamad Azfarhad Azizan, Mohammad Faiz Roslan. All authors reviewed the results and approved the final version of the manuscript.

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