

# Design of Cockle's Meat Separator Machine Using Cost Based Design Method

Afiq Hassan, Nik Hisyamudin Muhd Nor<sup>1\*</sup>

<sup>1</sup> *1Faculty of Mechanical and Manufacturing Engineering,  
Universiti Tun Hussein Onn Malaysia, Parit Raja, 86400, Batu Pahat, Johor, MALAYSIA*

\*Corresponding Author: [nhisyam@uthm.edu.my](mailto:nhisyam@uthm.edu.my)

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## Abstract

Cockle is one of the seafood that Malaysian people love to eat and from this news, it shows that cockle industry is important in Malaysia because of the high demand. The lack of technologies in this industry have made the production of the industry been limited and cannot meet the demand that will be needed. This study is to design the machine to separate the meat of the cockle from it shell in automatic to enhance the production of the industry. The design is simple where there are two stages to separate the meat by using the crushing method and the next stage is by using the vibration screening to separate the meat from the shell. The design and simulation of the machine has been carried out using a SolidWorks application. The machine that has been design will help the small business company to growth by using the affordable machine in producing the meat that have been separate.

## 1. Introduction

Malaysia has achieved impressive economic growth, with an average annual GDP increase of 6.5% between 1957 and 2005. During the 1980s and 1990s, growth peaked at over 8% per year, driven by high levels of local and international investment. The country is a major producer of commercial hardwoods, rubber, palm oil, petroleum, and natural gas. Malaysia's educated workforce, developed infrastructure, political stability, and undervalued currency have attracted significant international investment. Overall, Malaysia's economic success is attributed to diversification, investment, and favourable industries.

Malaysia's comparative advantages, such as an educated and affordable labour force, developed infrastructure, political stability, and undervalued currency, have attracted substantial international investment. The government has implemented the New Development Policy (NDP) since the 1970s, aiming to balance wealth redistribution and economic growth. The policy focuses on providing economic opportunities and improving managerial and entrepreneurial skills for the Malays and indigenous communities. The private sector has been encouraged to actively participate in the restructuring process.

Malaysia's cockle industry is a significant contributor to the country's economy, accounting for approximately 11% of all fisheries production. In 1984, the country produced around 65,000 tonnes of cockles, establishing it as the most important aquaculture sector. The industry is primarily concentrated in the coastal areas of Kedah, Penang, Perak, Selangor, and Johor, with approximately 4,000 to 5,000 hectares of mudflats on the west coast of Peninsular Malaysia. In 2007, Malaysia produced 80,000 metric tonnes of cockles for both domestic consumption and export, solidifying its position as one of the largest cockle producers.

Traditionally, the cockle industry in Malaysia has relied on manual processes, which result in slower production and limited quantity. However, with advancements in technology, the industry has the potential for rapid growth. Introducing machines into the cockle processing can improve efficiency, increase production

capacity, and enhance product quality. Machines such as cleaning, grading, crushing, separating, and packaging machines can be developed to streamline the processes and meet the high demand for cockle products in Malaysia.

The growth of the cockle industry in Malaysia has increased the demand for its products, placing a burden on small businessmen to meet high-capacity requirements. Manual processing methods, particularly in the separation of cockle shells from the meat, have hindered their ability to keep up with customer orders. To compensate, they are forced to hire additional workers, incurring higher costs and lacking the technological advancements necessary for efficient production. Supporting these small businessmen is crucial to improving their production capabilities, reducing costs, and enhancing product quality in the market.

In order to address these challenges, a machine design project will be undertaken in three phases: concept design, clarification design, and detail design. The developed technology should be user-friendly, cost-effective, and easy to maintain, empowering workers to handle the machines efficiently. This initiative aims to assist small businessmen in enhancing their production capacity, improving product quality, and ensuring long-term sustainability in the competitive cockle industry. The goal of this project is to develop a design for the cockle's machine based on the budget needed

This research aims to contribute to the growth of the cockle industry in Malaysia by developing machines that simplify work processes, increase performance, and ensure high-quality production. It highlights the importance of supporting this industry through technological advancements and attracting attention from institutes and government agencies. The designed machines will enhance the industry's system and performance, enabling companies to sell their products with improved quality and efficiency. The focus of the research lies in understanding and maintaining the machine's mechanism for long-term success.

## 2. Methodology

This chapter delves into the detailed methodology employed for the research on the cockle machine. The process begins with the development of a basic concept, comprising an idea and a series of actions to implement it. The research emphasizes the significance of continuous research and improvement in achieving enhanced product design.

### 2.1 Methodology of Design

The main purpose of this machine is to efficiently separate the shell from the meat of cockles, enabling quick processing. Extensive research has been conducted to address related challenges in the project. This machine aids fishermen in separating large quantities of cockle shells swiftly, reducing the need for manual labour and associated costs. It streamlines the packaging process, ensuring the timely distribution of fresh cockle meat to customers. The project's objectives and identified problems have been established based on prior information about cockles and their processing.

### 2.2 SolidWorks

SolidWorks by Dassault Systèmes is a versatile CAD and CAE software used for solid modelling. It operates on various platforms like Windows, Linux, and macOS. This parametric feature-based tool is widely employed by companies to design product models and conduct prototype simulations to analyse functionality and mechanisms.

### 2.3 Cost Based Design

Cost-based design involves managing production costs and serves as a foundation for decision-making during product development. It considers material choices, development expenses, and production time to optimize cost-efficiency. This approach requires forward-thinking and skilful execution to achieve a balance between low cost and high quality:



### 3. Data analysis and Result

This chapter focuses on the project design phase described in methodology. We begin with conceptual design, exploring ideas and options through methodologies like brainstorming and sketching. Then, we move to detailed design, using prototyping and modelling to refine the design. Throughout the process, we analyse decisions based on feasibility, cost-effectiveness, and user requirements. The chapter emphasizes a systematic approach to develop a well-thought-out design aligned with project goals.

#### 3.1 Identifying Customer Needs

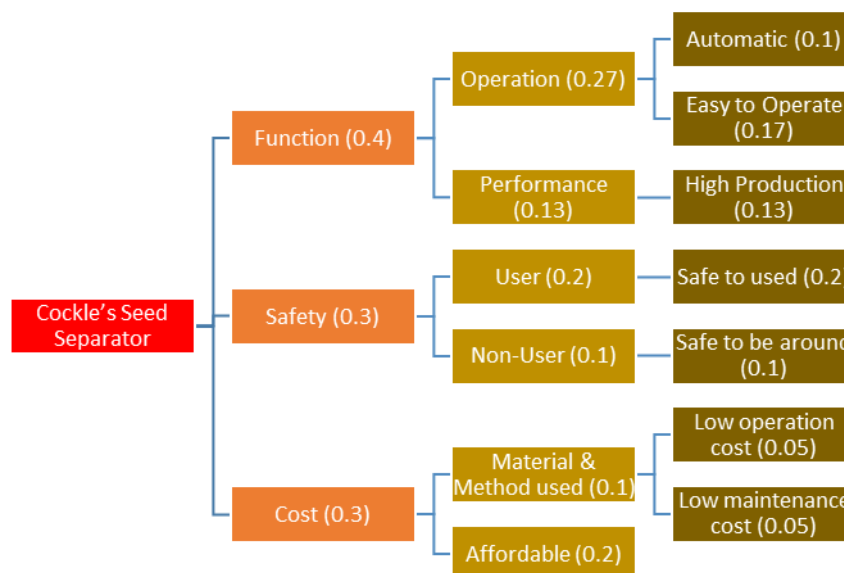
Visit has been done at the fisherman village to interview the small businessman to review about the aspect that need to be highlighted for the machine which are the function, cost, and safety. The total percent of the 3 aspects are 100%.

No.	Priority Requirement	Rating (%)	Weighting
1	Function	40	0.4
2	Cost	30	0.3
3	Safety	30	0.3
Total		100	1.0

From the table above, the function is the top priority of the aspect with score of 40% while for both of cost and safety elements score with the same rating which is 30%.

#### 3.2 Weighting Objective Tree

The Weighting Objective Tree helps prioritize objectives by assigning importance scales, enabling better decision-making. It ensures crucial goals are valued and considered, aiding in selecting the option that aligns with intended results. It provides a simple and logical approach to decision-making by considering the relative relevance of objectives.



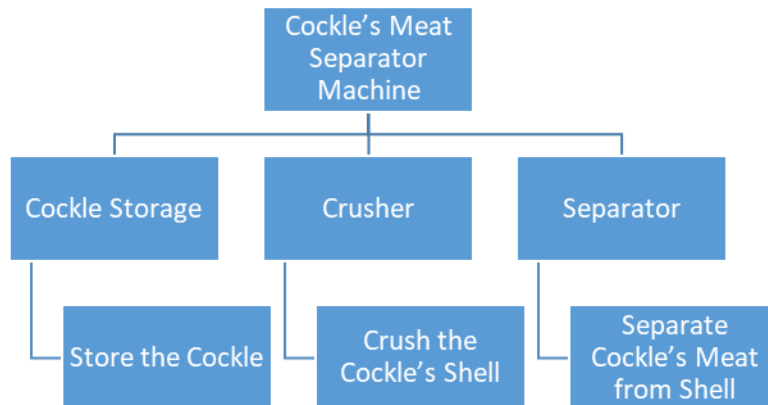
#### 3.3 Quality Function Deployment

Quality Function Deployment (QFD) is a method used to identify customer desires and translate them into manufacturing plans for customer-focused products. By recording customer demands and using scaling methods, the most important elements are prioritized. This helps in the subsequent design phase to develop products that meet customer needs effectively:

Indicator		Product Specification								
●	High	Important Weight	Power Supply (kW)	Operation	Weight (kg)	Dimension	Material	Price	Capacity	
▲	Moderate									
◆	Low									
●	Low									
▲	Moderate									
◆	High									
Indicator		No.	Customer Requirement							
1	Low			↑	↑	↓	↓	↑	↑	
2	Moderate									
3	High									
<b>A Function</b>										
1	Automatic		0.1	1	3			2		
2	Easy to operate		0.17			1				
3	High Production		0.13	2	1	2			3	
<b>B Safety</b>										
4	Safe to used		0.2			1	3			
5	Safe to be around		0.1							
<b>C Cost</b>										
6	Low Operation		0.05	1						
7	Low maintenance		0.05		1				1	
8	Affordable		0.2			1	2	2		
Total Importance			1.000	0.410	0.48	0.2	0.63	1	0.600	0.44

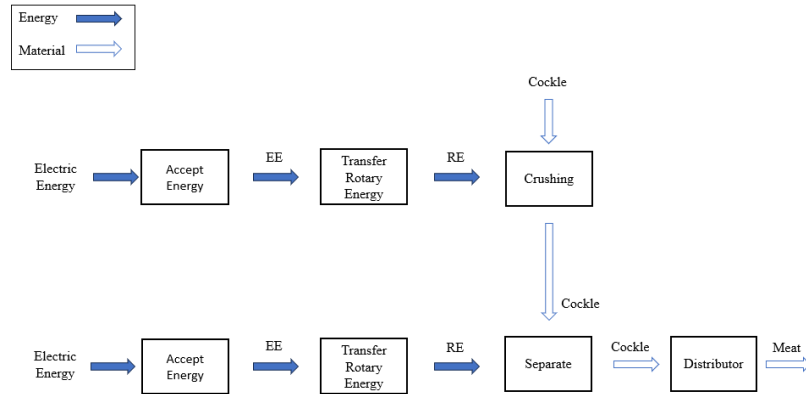
### 3.4 Function Decomposition Analysis

Function Decomposition Analysis simplifies complex problems by breaking them down into component elements. It helps clarify the relationship between components and their contribution to the main goal.



### 3.5 Function Structure

The function structure is depicted as a block diagram, illustrating the pathways for energy, material, and signal transmission between function blocks. It helps identify the limitations of new design functions and systems. The construction of movement processes in the cackle's meat separator follows the black box approach, referencing it from initial stages to completion.



### 3.6 Brainstorming







Brainstorming is a problem-solving strategy that encourages the development of unexpected ideas and solutions. It is commonly used by designers to generate new concept ideas. Brainstorming allows individuals to think freely and continuously generate ideas, promoting critical thinking and expanding the range of potential solutions. The process involves asking fundamental questions using the 5W1H method (What, Where, When, Why, Who, How) to generate new perspectives on existing problems.

Proposed Change	Description
Substitute	<ul style="list-style-type: none"> <li>What else can be add?</li> </ul> <p>Add the cockle’s meat separator machine in the industry to help the fisherman with their business.</p> <ul style="list-style-type: none"> <li>What can be improved?</li> </ul> <p>The method that been used to separate the meat can be change from manual to automatic which can save more time for the fisherman</p>
Combine	<ul style="list-style-type: none"> <li>How to combine the component of product?</li> </ul> <p>The cockle’s meat separator machine can integrate components such as crusher and vibrator to separate the meat.</p>
Adapt	<p>What else is like this?</p> <ul style="list-style-type: none"> <li>What is the others idea does this suggest?</li> </ul> <p>Can be used for the other type of shell food to separate their meat from it shell.</p>
Modify, magnify, or minimize	<ul style="list-style-type: none"> <li>Could we change the motion or form for the product?</li> </ul> <p>The size of the machine can be made as a compact machine with maximize its function.</p> <ul style="list-style-type: none"> <li>How to make the product stronger?</li> </ul> <p>As for this machine which is handling the wet material, it needs to be capable of withstand from damaged. So, we could use material that are stainless steel to build the machine.</p>
	<ul style="list-style-type: none"> <li>What other uses it has if we had modified it?</li> </ul> <p>As for this machine which it crushes the shell in both side with the same pressure, it could ensure the condition of the meat in a good condition so that it still marketable for the fisherman.</p>
Eliminate	<ul style="list-style-type: none"> <li>What part can we remove to reduce the weight of the product?</li> </ul> <p>The size of the body of the crusher can be reduce by using the leg to minimize the weight of the machine with the same capability to hold the machine safely.</p>

	<ul style="list-style-type: none"> <li>• How to reduce the cost?</li> </ul> <p>To reduce the cost of this machine, the design of the machine needs to be evaluated to ensure there is no unnecessary components that may increase the cost of the machine.</p>
Rearrange, reverse	<ul style="list-style-type: none"> <li>• Could we change the layout?</li> </ul> <p>The layout of cockle's meat separator machine can be position in many various positions to ensure the meat can be separated perfectly.</p>

### 3.7 Morphological Chart

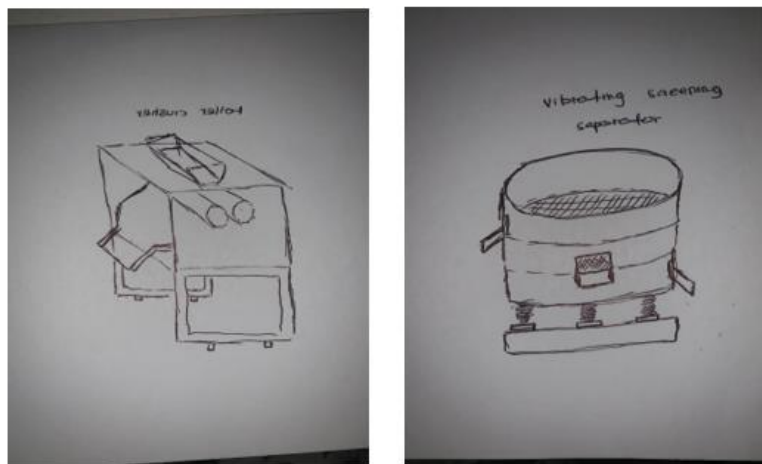
A morphological chart deconstructs problems into component elements and offers various options for each component. These options are then combined to generate a wide range of potential solutions. The chart is constructed by listing product functions independently and investigating combinations. By combining specific components, the fundamentals of a solution can be discovered, making the problem-solving process deliberate and intentional.

No	Function	Alternative 1	Alternative 2
1	Accept Energy (Crusher)	<p>AC motor</p> 	<p>DC motor</p> 
2	Transfer Rotary Energy	<p>Gear</p> 	<p>Belting</p> 
3	Cockle Crusher	<p>Roller</p> 	<p>Impeller</p> 

4	Separator	<p style="text-align: center;">Vibration Screening</p> 	<p style="text-align: center;">Hydro cyclone</p> 
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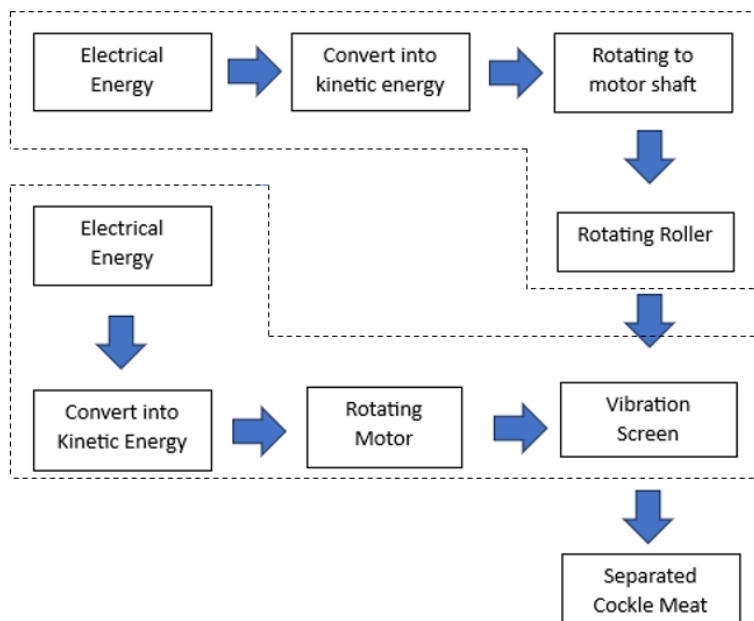
### 3.8 Product Sketching

Product sketching is a form of sketching that is used in product design. It is the process of producing hand-drawn or digitally produced drawings to illustrate and express design thoughts and ideas for tangible products.



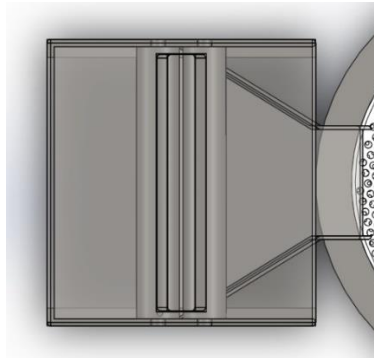
### 3.9 Grouping of Schematic Elements

Grouping schematic elements involves organizing and categorizing components based on their relationships or functions in the diagram. This classification enhances the clarity, accessibility, and understanding of the schematic illustration.

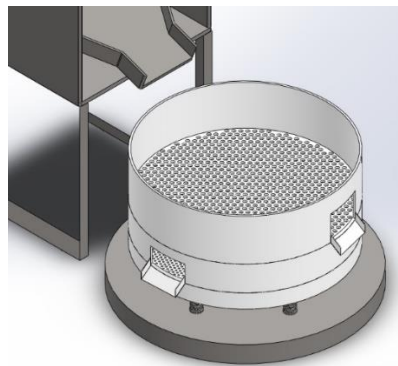


### 3.10 Simulation

Steamed cockle is fed through a feeder to crush its shell without damaging the meat. The motor provides kinetic energy to the shaft and gear, enabling rotation and energy transfer. The rotating gear drives the roller, applying sufficient force from the motor to crush the cockle shell effectively.



After crushing, the crushed shell and meat are dropped through an incline plane with the help of water as a lubricant. They then enter a vibration screening machine where high vibrations from a motor separate them. Larger shell pieces stay on the top level, while the meat passes through the holes to the second level. The smallest shells and other small materials go to the lower level. The separated meat can be easily collected by employees from the machine's distributor.



### 3.11 Parametric Design

Parametric design is a method of developing and altering design components and systems that makes use of parameters and algorithms. It includes establishing and regulating the interactions between multiple design factors using mathematical equations, rules, and algorithms, allowing for flexible and efficient design processes.

Gear Set 1

Gear		$P_1$	$G_1$
Ratio, $M_G$		3	
No. of Teeth, N		15	45
Speed, n (rpm)		690	230
Torque, T (Nm)		15.2	45.6
Diameter Pitch, $D_P$ (mm)		45	135
Module		3	3
Contact Ratio		1.61	1.61
Force, F (N)	$F^t$	675.6	675.6
	$F^r$	245.9	245.9

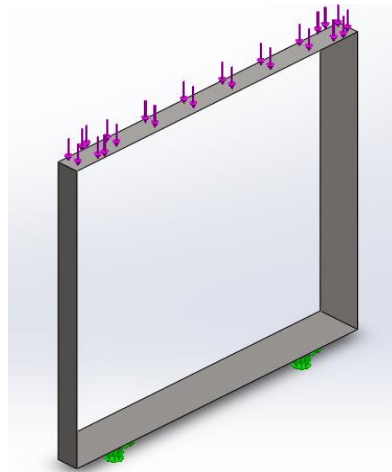
	$ F $	718.96	718.96
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## Gear Set 2

Gear		$P_2$	$G_2$
Ratio, $M_G$		4	
No. of Teeth, N		16	64
Speed, n (rpm)		230	57.5
Torque, T (Nm)		45.6	182.4
Diameter Pitch, $D_P$ (mm)		48	192
Module		3	3
Contact Ratio		1.64	1.64
Force, F (N)	$F^t$	1900	1900
	$F^r$	691.5	691.5
	$ F $	2021.9	2021.9

### 3.12 Structural Analysis

Structural analysis in design involves investigating and evaluating the structural integrity, stability, and performance of a design or structure. It uses principles of structural engineering to analyze how the design will behave under various loads and conditions. SolidWorks is commonly used for this analysis, which includes testing stress, displacement, strain, and factors of safety.



### 3.13 Cost Estimation Analysis

The estimated cost of the machine is evaluated to determine its suitability for the small industry. The cost includes estimating the materials required and identifying trusted sources. Additionally, the value of each component used in the machine is determined to obtain an accurate cost assessment.

No	Component	Cost (RM)	Quantity	Total Cost (RM)
1	Motor (vibrator)	800	1	800.00
2	Motor (Crusher)	1300	1	1300.00
3	Spring	10	6	60.00

4	AISI steel sheet (3mm)	6/kg	133	798.00
5	ABS Plastic sheet	14/kg	45	630.00
6	Gear Box (custom)	3000	1	3000.00
7	Polyethylene PE HDPE Sheet	7.2/kg	5	36.00
				6624.00

### 3.14 Product Specification

Product Specifications is the simple structural that are focusing on the all the information that are related to the machine. The specifications cannot be too technical to ensure that the customer can understand their need and why they should buy the product.

Product Specification	Description
Motor Power	1.5kW, 0.75kW
Material	Stainless Steel, Alloy Steel, Polyethylene Plastic
Weight	190 kg
Dimension	1600mm x 1000mm x 1200mm
Price	RM 9000
Capacity	200kg/hr

## 4. Conclusions

In conclusion, the Cockle's meat separator machine was designed to automate the process of separating cockle meat, providing an opportunity to assist small businesses like fishermen. User needs were considered to ensure ease of use and optimal performance. The machine has low complexity, making it user-friendly. The estimated development cost is suitable for the small industry, considering the size and material selection within budget constraints. The project objective of designing the machine based on cost requirements has been achieved, simplifying, and reducing the time and cost of manual meat separation.

## Acknowledgement

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