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Design and Development of Pahang Black Sambal Cooking Machine for Small and Medium Enterprises

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Abstract--- Pahang Black Sambal is a traditional food derived from the areas around West Pahang namely Kuala Lipis, Jerantut and Raub. This black sambal is uses the flavours of the people around West Pahang and has since become more popular throughout Malaysia. This emerging opportunity began to increase the interest of the young locals to empower the making of this type of sambal. Hence, various initiatives provided by the government attracts new entrepreneurs to venture into the Small and Medium Industry (SMI). This study is aimed at innovating the design and development of special machines to enhance the productivity of Pahang Black Sambal, thereby helping existing operators meet the growing demands of customers. The steps taken are target specifications, generate the concept, choose the concept and test the Black Sambal Cooking Machine. Then when the final specification and concepts are chosen, the development of the product can be done.

Keywords--- Pahang Black Sambal, Cooking Machine, Small and Medium Enterprise, Machine Design.

I. Introduction

Pahang Black Sambal is one of the most popular menus in Pahang. In 2013, at the national level Farmers' Fair, Tengku Puan Pahang officially declared the name Black Sambal to Pahang Sambal [1]. According to Tunku Azizah, Black Sambal is based on four main ingredients, namely bird's eye chilli, onion, averrhoa bilimbi and starch that has been boiled [2]. Black Sambal production was passed down to generations in parts of the District of Pahang namely Kuala Lipis, Jerantut and Raub. The traditional food of the Pahang state, inherited from this hereditary, has become the identity of the three districts for its distinctive privilege, increasing the appetite of anyone. Many think only skilled people can afford this black sambal [3].

The delicious food of this tradition makes it an optional menu in the State of Pahang and is well received in other countries. But its complicated way of making it harder to commercialize. Making Black Sambal is divided into three ways that are raw, cooked and cooked dry. On this day the demand for Pahang Black Sambal is increasing as it feels good to increase the appetite. The request does not come around Pahang only, but goes beyond that. Pahang Black Sambal fans are spreading to other states. Therefore, the demand for this product is bigger and gives space to entrepreneurs from Pahang itself to produce Pahang Black Sambal products. It ranges from Small and Medium Enterprise (SME) manufacturers to the Home made versions. Many efforts have been undertaken by government agencies and departments especially the Pahang State Government to develop this product throughout the country from the provision of major materials. The Federal Agriculture Marketing Authority (FAMA) is now actively involved in planting averrhoa bilimbi to meet the demand for farming entrepreneurs working on black sambal products. To date, there are about 100 farmers cultivating the area involving over 50 hectares in the district, Raub and Jerantut, and their numbers are expected to increase gradually. These efforts can help further develop this unique product company more widely and extend to neighboring countries.

To meet this requirement, based on the studies conducted by Baregheh, Rowley, Sambrook and Davies [5] researchers need to explore the potential to encourage and support SMEs in the food sector to engage in more collaborative innovation. Advice and support should also be offered on innovation processes and activities, specifically focusing on SME support in the food sector to evaluate technological advancement towards improving business performance.

Currently, there is only one entrepreneur from Bentong, Pahang namely Mr. Khairril Adzaha Awahabthat uses a special machine to stir Pahang Black Sambal designed by Syarikat Zul Design Acedemy [6] which takes two hours

thirty minutes for 10 kilograms of sambal. In addition, there are also business operators using the dodol stir machine to facilitate the stir process and cook Pahang Black Sambal, among them is Mr. MohdRidhuan Ghazali, SME businessman from Kuala Terengganu. Through the help of the machine, he needed 10 hours to cook 15 kilos of Sambal Hitam Pahang [7]. But all the existing machines only cover the cooking process. The time of preparation of the material needs to be allocated the previous day.

Therefore, this study is to identify the needs of SME entrepreneurs to further develop the concept of Pahang Black Sambal Cooking Machine in order to help entrepreneurs produce Pahang Black Sambal more productively. The study also incorporates the process of preparation of materials and cooking processes in one machine unit.

II. Literature Review

Along with the development era in Malaysia, the 11th Malaysia Plan has planned a number of initiatives that help to continue the SMI direction in Malaysia. The endless government support provided space and opportunities for new entrepreneurs to continue to generate lucrative income thus impacting the economy indirectly. To meet the growing demand of various techniques, ways and innovations introduced to increase product production.

According to Lee [8] increased enthusiasm highlighted by the government in implementing the SMI policy which aims to increase the capacity of innovation in SMIs. Despite these various initiatives, there is a lack of clear imperative research on the determinants of innovation in the SMI sector. Through the study conducted, the innovation in the manufacturing sector in Malaysia is complicated.

Thus, according to Muhammad Khaliq, Abu Hassan, Jamal and Adel [9] in the intellectual capital knowledge-based economy gradually replacing modern physical assets of the enterprise. It is indispensable for modern and high-tech enterprises to be given full attention not only in product innovations, marketing channels, markets and services, but also they need to enhance the capabilities of research and development of markets and products, and pay attention to sowing and managing the intellectual capital of entrepreneurs.

Making of Pahang Black Sambal in traditional way takes more than 3 hours for 2 kilograms sambal needs to be stirred endlessly to prevent burns and damages. The preparation of averrhoa bilimbi acids (the main ingredient of black sambal) also takes a long time of eight hours for twenty kilograms of starfruit [3]. Pahang Black Sambal is prepared in two ways, wet and dry. However for the marketing of black sambal products that require a long time and a large capacity of drying techniques physically drying meals are strongly encouraged where the water content in the food is reduced by using the technique of drying or oven. According to Safnowandi [10] this curing technique indirectly slows the growth of microorganisms in food while prolonging the shelf life of food.

2.1 Concept Machine

According to records from the United States Patent Office design of the first cooker-mixer was registered on January 25, 1962 by Alvin Hock, Sr. from Cincinnati, Ohio. This design is intended to enhance cooking and blending work which was formerly known as steam jacketed kettle [11].

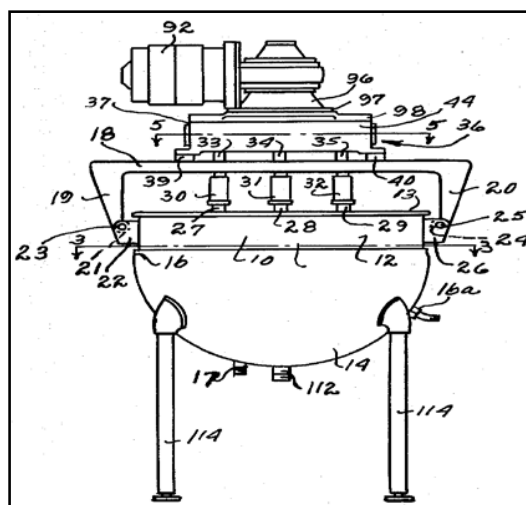


Figure 1: The first patented design at USTPO [11]

In Malaysia there are two types of local produce machines used by SME operators such as DodolMixer Cooking Machines from Pasir Mas, Kelantan. This machine is suitable for cooking dodol, serunding, chilli paste, tomyam paste and so on.

This machine comes with a 37-inch stainless steel pan, stirrer blades, adjustable fire burner kitchen. It is strong and solid in design and its height is adjustable through a barrier bar. The condition of the pan is adjustable so it is very easy to pour the ready-cooked ingredients. In addition, this machine has 4 wheels / tires to facilitate the movements [12].

Table 1: Intake Table of Cooking Machine Specifications [12]

Item	Specification
Power	1HP, 230V
Type	37" Cast Iron Wok Adjustable Height
Dimension	45" x 31" x 64" (L x W x H)

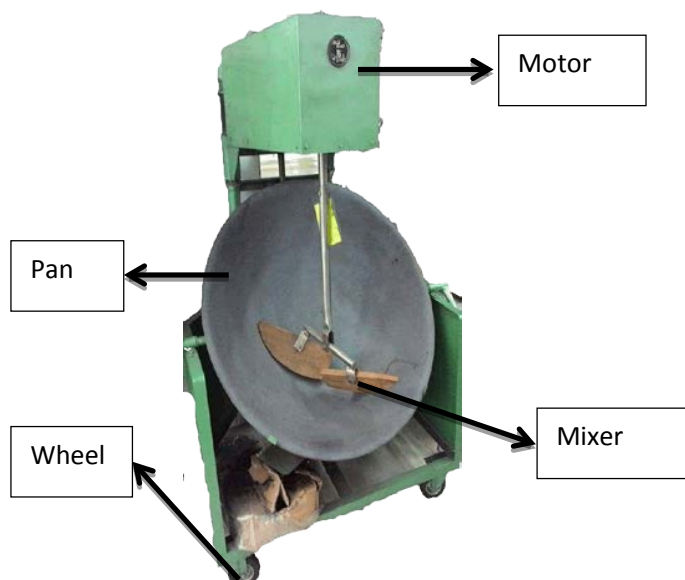


Figure 2: Dodol Mixer Cooking Machine

The Black Sambal Mixer Machine designed by Zul Design Company Acedemy has helped Mr. Khairril Adzaha Awahab, one of the SME entrepreneurs for Black Sambal products in Bentong, Pahang. This Black Sambal Mixer Machine comes with its safety features and designs according to the Pahang Black Sambal production. This machine is also made of stainless steel that ensures it is safe to use and eaten [6]

All machines designed only cover the cooking process. There is still no machines that includes cooking and preparation

Table 2: Table of Determination of Black Sambal Mixer Machines Specification Table

Item	Specification
Power	1HP, 220-240V, AC
Material	Stainless steel
Heating Element	(LPG)



Figure 3: Black Sambal Mixer Machine

III. Research Methodology

This study utilizes the product development process developed by Ulrich and Epingger [13]. There are involve eight steps to take to develop this product. The first is to identify the customer's needs, then getting the target specification, generating the concept of Black Sambal Cooking Machine, choosing the concept of this machine, testing the machine, getting the final specification then finally is developing the product and planning downstream development.

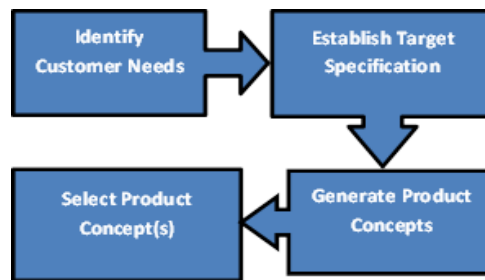


Figure 4: Product Development Process developed by Ulrich and Epingger [13]

Identify Customer Needs

An interview was conducted with several SME entrepreneurs to determine the problems that faced them. The list of Black Sambal entrepreneurs are tabulated in Table 3.

Table 3: List of Sambal Hitam Entrepreneurs

No	Experience (Years)	Machine	Type of Sambal	Capacity For One Cooking Time	Cooking Time (Hours)	Raw Material Preparation (Hours)
1	15	No	Dry	6 kg	6	3
2	10	No	Wet	15 kg	5	5
3	10	No	Dry	10 kg	12	6
4	15	Yes	Wet	20 kg	10	6
5	10	Yes	Wet	100kg	8	6
6	18	Yes	Dry	10kg	2.5	3

The data from the interview was used to develop the requirements specified by the customer. The data was compiled to get target specification for Black Sambal Cooking Machine.

Table 4: Mission Statement for Black Sambal Cooking Machine

Mission Statement: Sambal Hitam Cooking Machine Development Project	
Product Discription	Mobile, can produce black sauce up to a maximum of 10 kg in one cooking process
Advantages of the Project	Produces a faster Sambal Hitam, clean and reduces the workforce.
Project Development Goals	Makes SME Sambal Hitam more competitive.
Main Market	SME Entrepreneur of Sambal Hitam around West Pahang.
Second Market	Food preparation operators throughout Malaysia
Assumptions	Mobile
	Clean
	Save the workforce
	Electric Power Supply (AC)

Table 5: Needs data from entrepreneurs

No.	Needs	Number of Entrepreneurs
1	Sambal Hitam machine that helps speed up cooking proses and preparation of ingredients.	6
2	Portable	6
3	Able to control temperature	1
4	The process of transferring Sambal Hitam from the machine is easier and cleaner.	6
5	Offer a cheap price	3
6	Easy machine control	3
7	The machine is able to maintain the same taste with traditional manufacture	6

Table 6: Customer Data Template

Customer : AyuAdila Binti Mustafa		
Address	: No. 50, Batu 11, Jalan Gambang, 26070 Kuantan,	Pahang
Pekerjaan: Pengusaha Sambal Hitam Pahang		
Currently Used	: Dodol Mixer Machine byMRZ Machinery	
Question	Customer Statement	Interpreted Need
Typical uses. Likes- current tool	Facilitate cooking process No longer need to stir the <i>sambal hitam</i> during cooking	More effective Easy operation
Dislike current tool	It is hard to remove the <i>sambal hitam</i> from existing pans	Flexible size and design Facilitate the process of lifting the cooked <i>sambal hitam</i> .
Suggest improvement	It's easier to move Accelerate cooking operations The final process of picking up cooked <i>sambal hitam</i> is easier and cleaner. Combine the process of preparation of raw materials and cooking in one machine unit	Design that meets the demand More effisen

Establish Target Specification

Based on the interviews, the target specification of the Black Sambal Cooking Machine can be framed correctly. With this product it can be produced more easily because it has a target specification. Product Specification of Black Sambal Cooking Machine has its varieties and does not mimic the existing designs.

Innovation was done to ensure that it meets the requirements of customers who will use this Black Sambal Cooking Machine. The main specification on this product is mobile and facilitates the manufacture of Black Sambal from preparation of ingredients to cooking. This is the specification set for this product.

Before develop target specification, the customers needs was conducted. The first step is to collect raw data from entrepreneurs. 6 entrepreneurs have been interviewed 3 of them already using machine in production Black Sambal and another three entrepreneurs still using traditional way in to produce Black Sambal.

Table 7: Customers needs

No.	Need	Imp.
1	Sambal Hitam Cooking Machine The machine is easy to divert	4
2	Sambal Hitam Cooking Machine The machine can help speed up the cooking process	5
3	Sambal Hitam Cooking Machine Combine cooking and material preparation process	5
4	Sambal Hitam Cooking Machine Easy to handle	3
5	Sambal Hitam Cooking Machine The machine is clean and safe to use	4
6	Sambal Hitam Cooking Machine Its affordable for an entrepreneur	2
7	Sambal Hitam Cooking Machine This machine has a flexible and easy-to-use design	3

Table 8: List of Metric Suspension.

NO	Need nos.	Metric	Imp.	Units
1	1,4,7	Total weight	4	Kg
2	2,3,7	Operational time	5	M
3	1,4	Total Length	3	Cm
	1,4	Cooking capacity	4	Kg
	1,4	Total width	3	Cm
4	6	Unit manufacturing cost	2	Rm
5	4,5,7	Easy to used	3	Subj
6	1,2,3,4,5,6,7	Specific Design	5	subj

This data was taken from the questionnaires conducted on the customer. Table 7 shows the main customer requirement. The scale used is 1 - 5 to show the customer's wishes.

Upon identifying customers' requirements, the target specification has been set. In addition, there is a specification that can be expressed as it relies on the product concept. Table 8 shows the list of targeted matrices.

After the completion of the completed matrix, the competitor's benchmark information chart was generated. Comparison is based on information obtained by the customer to meet the requirements. For this machine, comparison has been done only with machine produced from Malaysia and already use by Black Sambalentrepreneur.

Table 9: Competitive Benchmarking for Black SambalCooking Machine

No.	Need nos.	Metric	Imp.	Units	Dodol Mixer Cooking Machines MRZ Machinery	Sambal Hitam Mixer Machine Zul Design Academy
1	1,4,7	Total weight	4	Kg	25	30
2	2,3,7	Operational time	5	M	540	150
3	1,4	Total Length	3	Cm	100	130
	1,4	Cooking Capacity	4	Kg	10	10
	1,4	Total width	3	Cm	100	60
4	6	Unit manufacturing cost	2	Rm	7000.00	7500.00
5	2,5,7	power	3	V	1 HP, 230V	1 HP, 220 - 240V
6	4,5,7	Easy to used	3	Subj	3	3
11	1,2,3,4,5,6,7	Specific Design	5	subj	2	3

Table 10: Target Specification for Black Sambalcooking machine

No.	Need nos.	Metric	Imp.	Units	Marginal Value	Ideal Value
1	1,4,7	Total weight	4	Kg	>30	<30
2	2,3,7	Operational time	5	M	>180	<150
3	1,4	Total Length	3	Cm	>130	<130
	1,4	Cooking Capacity	4	Kg	<20	>15
	1,4	Total width	3	Cm	>100	<100
4	6	Unit manufacturing cost	2	Rm	>7000.00	<7000.00
5	2,5,7	power	3	V	1 HP, 230V	2 HP, 220 - 240V
6	4,5,7	Easy to used	3	Subj	<3	>5
7	1,2,3,4,5,6,7	Specific Design	5	subj	<3	>5

Table 9 shows the competitive benchmark. Based on the comparison made by all the relevant information, target specification was developed for Black Sambalcooking machine.

The target specifications are shown in Table 10. Upon finished the target specification, the concept generation is developed. The next section discussed detailed of concept generation for this machine.

Generate the concept

Once all the problems have been identified, the next step is to generate a product concept. The concept of this product is produced based on the specifications obtained in previous steps. This section is divided into two parts, the first part explained the five sketches of the portable Black Sambalcooking machine while the second part is an explanation of the concept of a Black SambalCooking Machine product that meets the needs of customers.

The design concept is an early Black SambalCooking Machine development step. It includes the main elements of this Black SambalCooking Machine. In this concept, five sketches were developed and the best concept was chosen.

The initial sketch develops based on customer requirement. Five initial sketches were done in order to generate product concepts.

Each sketch must have different characteristics of each other. After that, the concepts screening take place to choose the best concept for Black Sambalcooking machine.



Figure 4: First Concept

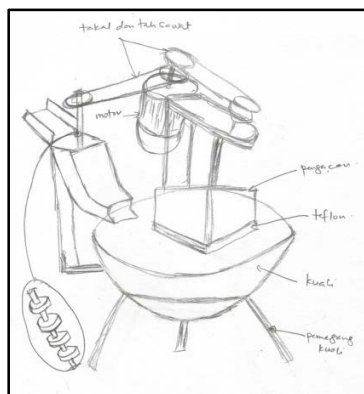


Figure 5: Second Concept

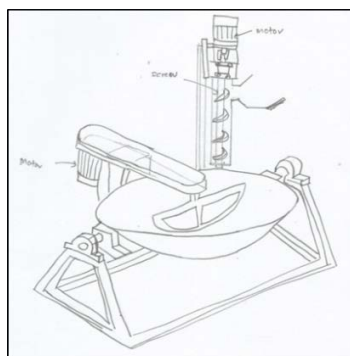


Figure 6: Third Concept

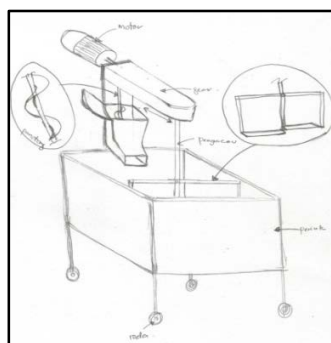


Figure 7: Fourth Concept

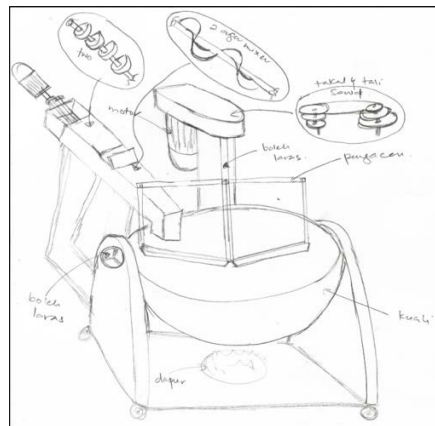


Figure 8: Fifth Concept

Table 11: The Concept Screening Matrix of Sambal Hitam Cooking Machine

Criteria Selection	Concept					
	1 st	2 nd	3 rd	4 th	5 th	6 th
	(REFERENCE)					
Function	0	0	0	-	0	0
Ease to use and handling	0	-	+	0	0	0
Weight	0	-	0	0	0	0
Installation and conservation	-	+	+	+	+	0
Safety	+	0	0	-	+	0
Durability	0	0	0	0	0	0
Aesthetic value	0	+	+	+	+	0
Trustworthiness	0	0	0	0	0	0
Ease of installation	0	-	0	-	-	0
Comfort	+	+	0	+	-	0
Sum +’s	2	3	3	3	4	0
Sum 0’s	7	4	5	4	5	10
Sum -’s	1	3	0	3	2	0
Net Score	1	0	3	0	2	0
Rank	3	5	1	6	2	4
Continue?	No	No	Yes	No	Yes	No

Select Product Concept

The screening concept as shown in Table 11 was established based on the method developed by Stuart Pugh in 1980. The purpose of this concept to determine the next stage of shrinking the concept and making improvements to the resulting product. Upon completed screening concept, the concept scoring take place.

Based on the concept scoring in Table 12 shows the scoring concept for Black Sambal cooking machine. Based on this concept, only two of the concept ideas chosen for the next step. The concept chosen was the concept of the third idea and the concept of the fifth. The third concept and fifth concepts were chosen because they have a high net score compared to other concepts.

The comparison was based on the provided references product. Each score was compared between concepts and references. The aspects taken into account were functions, sizes, weights, assemblies and calendars, safety, durability, aesthetic value, reliability and comfort. As a result of the comparison the fifth concept was in the second position, the second concept is ranked fifth, the fourth concept is ranked sixth, the third concept is in the first position and the first concept is third. Only the third concept and fifth concept are taken to the next level.

After this concept is classified and lined up according to the ability of this concept. Based on that table the third concept and concept of five have advantages over the other concepts. Then the concept of three and the five concepts were combined for subsequent improvements.

After the third and fifth concepts are combined and performed improvements. Marking filter table is created. This is an analysis using the matrix filter method as shown in Figure 9. This table is the same as the previous table but coupled with the concept of three and the concept of five.

After screening the concepts and scoring concepts in a variety of concepts one of the best concepts has been chosen to be the final concept for a more perfect design. It aims to produce more attractive and value-added products.

The selected design is a Black SambalCooking machine that combines two concept designs that make this Black SambalCooking machine more attractive and meet customer demand. The main design of this Black SambalCooking machine is shaped as if it were round. It is the inspiration derived from the big pan and flexible handle

In addition, the Black SambalCooking machine also has a wheel below to facilitate the movement process. This wheel has a key to prevent it from moving from its original position. The Black SambalCooking machine also combined prepared material process and cooking process in one unit machine. This is to facilitate the entrepreneur to produce Black SambalPahang in big quantity and decrease time limit. The panof the machine has also been modified to make Black Sambaleasier to transfer to the container after cooking.

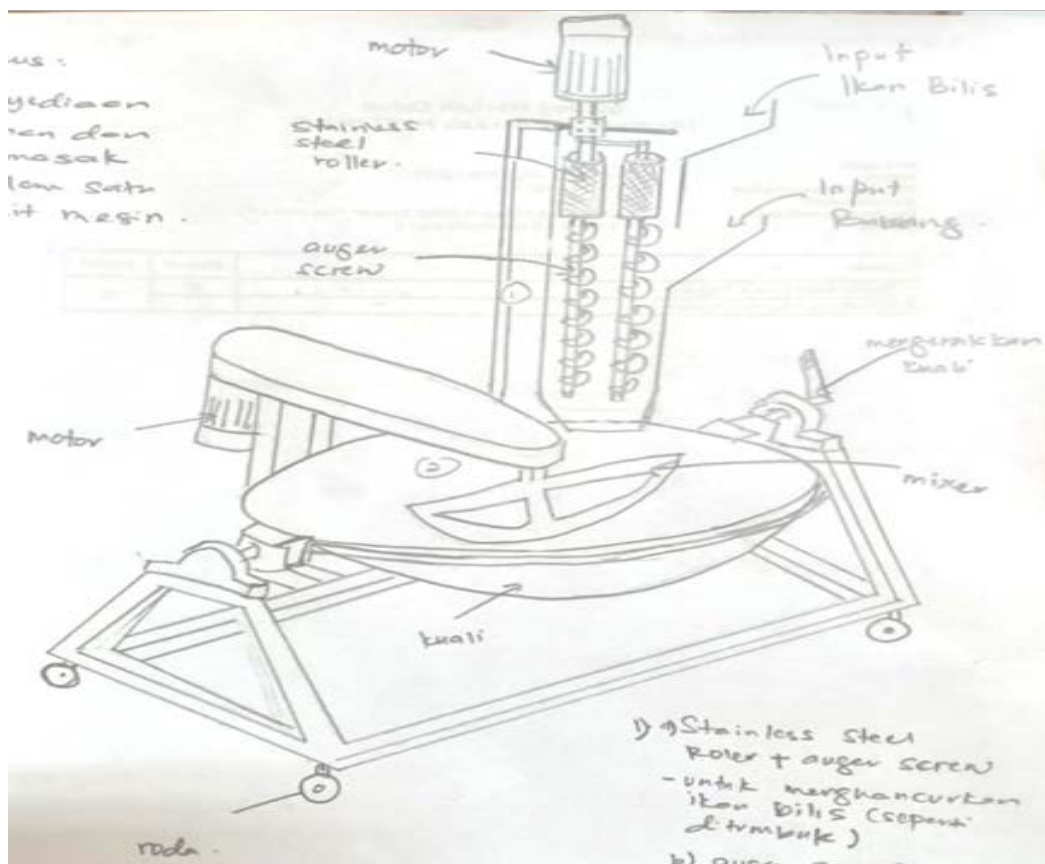


Figure 9: The best sketch

Table 12: Concept Scoring of Black SambalCooking Machine

Selection Criteria	Weight (%)	Concept											
		Concept 1		Concept 2		Concept 3		Concept 4		Concept 5		Concept 6 (Reference)	
		Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Function	30	3	0.9	4	1.2	4	1.2	3	0.9	4	1.2	3	0.9
Ease to use and handling	5	3	0.15	3	0.15	3	0.15	2	0.1	3	0.15	2	0.1
Weight Installation and conservation	5	2	0.1	3	0.15	3	0.15	2	0.1	3	0.15	2	0.1
Safety	15	4	0.6	3	0.45	4	0.6	2	0.3	3	0.45	3	0.45
Durability	10	3	0.3	2	0.2	3	0.3	3	0.3	4	0.4	2	0.2
Aesthetic value	5	2	0.1	2	0.1	3	0.15	3	0.15	3	0.15	2	0.1
Trustworthiness	5	2	0.1	2	0.1	3	0.15	2	0.1	3	0.15	2	0.1
Ease of installation	5	3	0.15	2	0.1	4	0.2	2	0.1	3	0.15	3	0.15
Comfort	15	4	0.6	3	0.45	4	0.6	2	0.1	4	0.6	3	0.45
Total Score			3.10		3.05		3.70		2.25		3.55		2.45
Rank			3		4		1		6		2		5
Continue?			No		No		Yes		No		Yes		No

IV. Conclusions

Based on concept development process, the final concept product has been chosen based on customer needs. The proses was completed step by step to make sure the final concept that has been design full fill all the requirement and specification. Therefore, last sketch for Sambal Hitam Cooking Machine is combined by two concepts to satisfied customer needs.

Acknowledgement

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