ARDUINO BASED SYSTEM FOR INGREDIENT DISPENSING IN GULA MELAKA PRODUCTION

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Report

Final Year Project I

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SUPERVISOR'S DECLARATION

I have checked this report and the report can now be submitted to JK-PSM to be delivered back to supervisor and to the second examiner.

Signature : .....

Name of Supervisor : .....

Date : .....

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LIST OF ABBEREVATIONS

ASEAN	Association of Southeast Asian Nations
FYP	Final Year Project
HOQ	House of Quality
QFD	Quality Function Deployment

LIST OF SYMBOL

P	=	Pressure
p	=	Density
v	=	Velocity
g	=	Gravitational Force
h	=	Height
m	=	Mass
A	=	Area
r	=	Radius
Q	=	Flow Rate
ΔV	=	Volume
Δt	=	Time

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CHAPTER 1

INTRODUCTION

”Arduino based system for ingredient dispensing in gula melaka production" entitled as the project background provided by this chapter. This chapter includes the problem statement, the objectives, and the scope of this project.

1.1 Background Study

Arduino is an open-source platform for beginners in working with the microcontrollers to build electronic projects. This platform build in a suite of programmable circuit boards, the Integrated Development Environment, and related accessories. The Arduino language is a set of C/C++ functions that can be use to write the code that tells the Arduino board what to do [1]. In other words, Arduino is a simple way for people to get started creating their own homemade gadgets. Satisfyingly, Arduino boards runs on Linux, Mac or Windows, by using an integrated development environment [2].

Gula Melaka is the type of palm sugar that originated in state of Malacca, Malaysia which is also known in English as “malacca sugar”. It usually sold in bottles or tin. It also can be sold in form of bricks or cakes but mostly in cylinders as in (Figure 1.1.1)[3]. Traditionally, it is made by extracting the sap from the flower bud of the coconut treefirst. The sap is then boiled until it thickens and left to solidify to form a shape and the product is then ready to be sold[4].

Figure 1.1 : Palm Sugar (Gula Melaka)

1.2 Problem Statement

Arduino in ingredient dispensing in palm sugar production is something that should be develop in industries presently due to their programmable functions that provide common control in the machine in performing defined task. The reason being is because the industry of palm sugar still relies on manpower in their production system[5]. Hence, by installing Arduino based system, the improvement in the palm sugar production system can be achieved. Other than fulfilling the production requirement, the Arduino based system can also reduce the laborwork.

1.3 Objective of Project

The objectives of this project:

1 To study and design an Arduino based system.

2 To build a product for ingredient dispensing using Arduino in improving the palm sugar production.

3 To test and analyze the process.

1.4 Scope of study

The scope of this project:

1 To analyze and improve the palm sugar production system.

2 To use the Arduino based system in the ingredient dispensing of the palm sugar production.

1.5 Summary of Project

This project will be covering the usage of the Arduino based system in ingredient dispensing to improve the palm sugar production system. This improvement will be focusing on the control of the machine to dispense the ingredient smoothly and accurately based on the quantity of the production. This improvement will also be focusing on the design of the ingredient dispensing model which will also aim to improve the system by reducing the manpower in the production. Buttons will be install on the machine for controling purposes. The idea is to reduce the labor cost and the time in preparing the ingredient for the production. The system also be high in safety factor and friendly uses.

CHAPTER 2

LITERATURE REVIEW

This chapter will be explain in details about the process of the palm sugar (Gula Melaka) production. Other than that, the overview about Arduino based system and the type of ingredient dispensing model will also be discuss in this chapter.

2.1 Palm sugar (Gula Melaka)

Gula Melaka or palm sugar is broadly used in ASEAN for dacades, mainly for cooking purposes. It is a nutrient-rich, low-glycemic crystalline sweetener that behave almost exactly like sugar. Palm sap which is the main ingredient can be collected from the flowers that grows high on coconut palm trees, also known as the liquid flower nectar or *neera*. Traditionally, the fresh palm sap is boiled down shortly after collection to make palm syrup and then the palm sugar itself. The process arrangements are cooking, pouring, cooling, demoulding and packaging of palm sugar[6].

Palm sugar is nutritionally sweet and contained some vitamins which is good for the human body. It also can be use as an additional sweetener in every food consumptionin human daily routine [7]. So as humans, it will be a waste if no action is taken to draw out all the beneficial juices from the palm sugar production.

2.2 The Palm Sugar Production Machinery

In Malaysia, the traditional processing of palm sugar is highly labored, as follows there will be limited production outcome to fulfill consumer demand even though there are many

emerging food technologies, but none of them are implemented in the processing of palm sugar[5].Traditionally, P. Naknean et al. [8]states that in producing palm sugar, the palm sap was evaporates in an open pan until it becomes concentrated, using a wood fired stove as a heating source and then remove the concentrated palm sugar syrup from the pan for the cooling down process. Lastly, poured the finish product in moulds so that the product will be solid block and ready to be sell.

Consumers nowadays preferred in palm sugar derived from palm tree sap compared to other sugar products. In other words, palm sugar industry is an alternative way to improve the well-being of the community, because the processing is still done traditionally. Thus, the opportunities for the manufacture of palm sugar for utilization of palm trees is still wide open. The demand for goods is not progressing very smoothly and most of the production is a failure[9].

In this era, the involvement of machinery is accountable as an obligation in any industrial production system nowadays in achieving an innovative system for our next futuristic high-tech generation including the palm sugar production system. There are three different kind ofingenious machinery for each process that will be briefly explain in this sub-chapter.

2.2.1 Evaporator Machine

During the evaporation process, the physical and chemical changes which is the impartion of the unique colour and flavour features happen as a result of the longer sap is boiled, the darker it becomes [10]. There are two different kind of machines include in evaporator machine.

First is by R. Hasan et al.[11]that usedan electrical heater to heat the palm sap to produce the palm sugar and uses a controller to control the temperature so that the cooking process is maintained in order to produce a more balance process. Second, H. Aripin et al.[12]produced the palm sugar by evaporating the palm sap in the closed evaporator and heating is performed using a gas burner where the gas output is the LPG gas cylinder which regulated by an output valve installed between the gas burner and the gas cylinder.

2.2.2 Stirrer Machine

Stirrer machine is the machine that stir the ingredient(palm sap) during the ongoing heating process to produce a uniform and balance viscosity of the palm sugar. K. D. McCranie et al. [7]used an automated stirrer machine by controlling it using language C that has been program in the microcontroller of the system. By doing this, they can control the speed of the stirrer machine following the temperature that applied in the heating process.

2.2.3 Mould Machine

In traditional method, K. A. Azlan et al [6] states that the bamboo moulds need to be moist for easy demoulding process. This will allows some water from the bamboo to be absorbed by palm sugar. Thus, in order to eliminate this process, aluminium mould was produce that consists of“mould inserts” withtapered drilled bore holefor easyseparation of the palm sugar fromthe mould in other word this will make iteasier for maintenance and cleaning purposes.

2.3 The Process of Palm Sugar Production

In A. Iskandar et al [13] studies, they state that the palm sugar is produced from the palm sap by manually collected it from coconut palm trees. Currently, most of palm sugar production is based on the following traditional method the sap is poured in a large openpan and heated usinga wood fired stove as a heating source.

Usually the process of palm sugar production start off with the fire intensively cooking in order to accelerate the evaporation of water from the palm sap. Then the palm sap is boiled at a temperature of over 100 °C for a few hours until the concentration increases and turn into palm sugar syrup. After that, this substance is manually stirred with large wooden spoon until it becomes viscous and during thison-going process, the changes of its brown colour can also be observed. This changes is where the producer determines the final product quality based on the intensity of its brown colour, thickness and viscosity of the liquid during the stirring process [12]. Lastly, the final product is produced after its cool down and poured into a bamboo moulds in order to get the cylindrical solid block for selling purposes.

2.4 Microcontroller Application

In modern days, controlled or automated system is something that our generation uses in making a bright and innovative future that change most of the labor production into machine production. Unfortunately for the most of active palm sugar production, researches worldwide are only focus on dealing with the quality and properties of the palm sugar itself instead of the production process [14]. Thus, in order to counter this and produce an automated production machine, this is where the involvement of microcontroller takes place.

A microcontroller is a programmable processor-based digital IC widely used in control electronic systems, where the microcontroller will be the digital system in charge of executing programs and performing tasks through a Central Processing Unit.Just as human beings obtain information from their surrounding environment through their senses and the information is then process using their brain, same goes for electronic systems that try to do the same by means of devices in the same manner with microcontrollers. Thesesensors and processing digital devices are present everywhere including industry production system, and they have become necessary in our daily lives for it to run smoother [15].

2.4.1 Programmable Logic Controller (PLC)

V. Hoxha et al[16] states the different between the PLC comparing to the open source hardware and software using open source micro-controllers is that it supports industry standard voltage and current ratings of different sensors, including Analog to Digital Converters (ADC) for interfacing with sensors producing standard values. In addition, the industry digital inputs also supported by PLC and the other modular extensions that can support sensors using strain gages, thermocouples etc. Unfortunately, the PLC come with great disadvantage of high price for both the hardware and the software license for programming butthe main disadvantage of the PLC is that it requires interfacing for the industry standard voltage ratings for inputs, outputs, sensors and other hardware.

Figure 2.4.1 : Programmable Logic Controller (PLC)

2.4.2 Arduino

The Arduino is an open-source electronics platform for beginners based on adaptable hardware and software, which is a central control unit of many embedded controls. The Arduino board is programmed to behave as a servant with its inputs and outputs are used for interaction with the physical world. Currently the Arduino UNO, Arduino MEGA2560 and Seeeduino Mega boards are supported with the sketch 3 can be easily modified for other boards. This works the Arduino receives commands from the master via USB connection, and then performs the requested operations and responds to the master. The response may contain just a confirmation or the requested data[17].

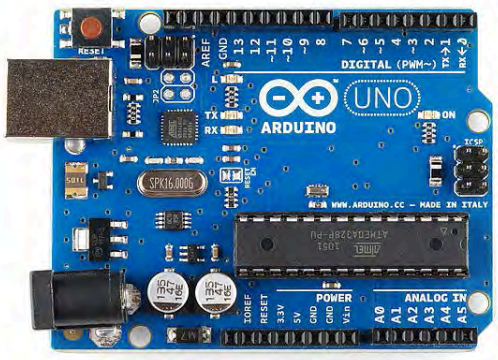


Figure 2.4.2 : Arduino Mega

2.4.3 Raspberry Pi

J. A. Rossiter[17] mention that the Raspberry Pi is like a credit-card sized computer which is capable of running applications just like a standard desktop PC that based on Broadcom BCM2835 SoC, which contains a 700 MHz ARM1176JZFS CPU with hardware floating point unit. Plus, the onboard memory is 512 MB. It is a master that controls the Arduinowhich appears as a standard serial port upon connections with the USB cable so the commands for a certain amount of tasks is sent as soon as they are written to the appropriate serial device. In a short term, Raspberry Pi is the main control unit of the system. Although The Raspberry Pi initially developed to increase interest in programming and software engineering, but surprisingly it soon became accepted as a universal programmable control unit for many machines and M2M applications.

Figure 2.4.3 : Raspberry Pi

2.5 The Electric Push Button Ingredient Dispensing Model

N. Caywood and N. T. Wojciechowsi [18] mentioned that the idea of an automated ingredient dispenser is purposely to counter the manually dispensing ingredients which can be time-consuming, inaccurate, and plain messy. The ingredient dispenser have to be

capable to be use anywhere and at the touch of a button it can dispenses the requested amount of ingredient and bring ease for the use by the consumers. The system works when the user inputs the amount of the ingredient they need and uploads the sketch to the Arduino, then a linear actuator is active. Then, a load cell attached to a converter reads accurately reads weight values and sends a command back to the Arduino to retract the linear actuator when the requested amount has been dispensed.

2.5.1 The Fluid Ingredient Dispenser

C. J. Huang and F. T. Tsai [19] stated that the current fluid ingredient dispensers available in the market cannot provide the amount that the users set where the fluid ingredient filling cannot be stopped automatically which is not convenient and cannot satisfy the real needs of consumers. In order to counter this, the fluid ingredient dispenser adopts the 8052 Micro Controller Unit program control in the circuit design to control the fluid release time and flow rate of the fluid ingredient to obtain the amount required by the consumers. In addition, a voice prompt is provided when the fluid ingredient filling action is completed andif the fluid overflows, the fluid ingredient filling would be stopped automatically without wasting anything. It can actually achieve the purposes of convenient and avoiding fluid ingredient waste.

2.5.2 TheDry Ingredient Dispenser

Thedevelopmentof an automatic dry ingredient dispensing system whereit will persistently dispense dry ingredients. This product aim to eliminate the tiring need for measuring cups and the unsightly messy tabletops. The dispenser will also have a user-friendly interface that allows for multiple unit inputs. Plus, it will lead to better consistency from one batch

of a recipe to another due to the automatic dispensing system. This product will also provide storage for dry ingredients and eliminate the need for complex conversions where the user need to store them in random place which can also be time-consuming[18].

2.6 Ingredient

First, the sweet watery Neera from palm tree will be heated to the extreme temperature range around 110°C to 130 °C and it exceeds the level of normal boiling point. Besides Neera, other ingredients such as water, coconut milk and pandan leaves can also be added. The pandan leaves was used as aroma booster and prevents the sugar from quickly spoiled [7].

C. Gilbert stated that the use sugar, honey, sugar and molasses, brown sugar, or even maple syrup can be the substitution of the palm sugar. The sweetness of the palm sugar can be substitute but nothing really equals to the dark flavor of palm sugar [20].

2.6.1 Neera

B. Misra[21] stated that the sweet sap of the coconut palm also known as Neera, has a high nutritious value, and it is nonalcoholic and notorious drink. Neera is also popular as a source of sugars, minerals and vitamins. Plus, it is sweet nectar type liquid, and translucent in oyster white color.

Neera Good Effects

- Good for improving the health.
- Supplement for iron and vitamin insufficiency.
- Medically applicable forasthma, tuberculosis, bronchial suffocation and piles.

- Facilate clear urination and prevent jaundice.
- Contains high amount of glutamic acid which is the amino acid used by the body to build proteins.
- Beneficial for the treatment of eye abnormalities, eczema etc due to high in inositol.

Neera is a product that can be found in the flower of coconut. It is extracted and collected by a tapper which obtained by tapping the coconut palm inflorescence. [22]. Treated neera can be packed in tetra packs or glass bottles and can be preserved in cans up to 2 months at room temperature.During the tapping process, a container is fastened to the flower stump of collect the sap. Then, the neera is brought down from the top of the tree in either earthen pots or vessels. After that, the neera is poured into stainless steel containers, at the same time the neera is being filtered through a fine mesh cloth or wire-mesh. Neera is collected every morning just at sunrise because as soon as the sun light hits the surface the very process of fermentation starts [21].

Figure 2.6.1 : Coconut Sap (Neera)

2.7 Bernoulli Principle

Swiss physicist and mathematician named Daniel Bernoulli made a history withhisdiscoveries in hydrodynamics. He was born into family of mathematicians on Feb 1700, and he was the only member of the family that make a mark in physics.

Referred to as Bernoulli Principle where he discovered that as the velocity of fluid flow increases, its pressure decreases. He used to produce a vacuum by connecting a vessel to a tube which water is running through it rapidly[23].

2.7.1 Bernoulli'sEquation

Bernoulli Principle is a principle that determines the relationships between the pressure, density, and velocity at every point and edge in a fluid mechanism.

Bernoulli's Equation:

$$P_1 + \frac{1}{2}pv_1^2 + pgh_1 = P_2 + \frac{1}{2}pv_2 + pgh_2$$

This equation says that the sum of the pressure (P), the kinetic energy per unit volume ($\frac{1}{2}pv^2$), and the gravitational potential energy per unit volume (pgh), has the same value at all points along a streamline[24].

2.8 Continuity Equation

The common applications of continuity equation are used in pipes, tubes and ducts with flowing fluids. The establishment of this Continuity Equation in fluid dynamics is the differential equation that represent the transport of some sort of conserved quantities [25].

Continuity Equation:

$$Q = vA = \frac{\Delta V}{\Delta t}$$

This equation containsthe flowrate (Q), the velocity (v), and the cross sectional area (A).vA is that the volumetric flow rate. This equation is a measure of the volume of fluid passing a point in the system per unit time.[26]

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter describes the methodology used in this project in obtaining data input for ingredient dispensing in gula melaka production by using arduino based system. This chapter will also cover the amount of work that needs to be carried out in order to accomplish this project. This project starts by studying the arduino software called The Arduino Software (IDE) in order to apply and create an automated arduino based system. Several parameters will bemeasure and collect which more focusing on the detailed amount of the ingredient used such as neera, coconut milk, pandan leaves and plain water. This data analysis compiles in order to develop aningredient dispensing system in gula melaka production. The flow chart of the project is shown in Appendix A which shows the progression of the methodology.

3.2 Microcontroller Application

In this project, the microcontroller will be used to process commands by using the language C using Arduino software. Then, the microcontroller will beprogrammedto follow the instruction by executing programs digitally and performing tasks through a Central Processing Unit. In the development of an automated system for the Gula Melaka production, microcontrollers is convenient due to its minimal size and cost. Plus, microcontrollers have the ability to maintain functionality while waiting for an event such

as a button press or other interruptions. The power consumption of the microcontrollers while sleeping is only nanowatts, which makes them suitable for any long-lasting battery applications. The microcontroller is also count as an adaptable system in terms of fulfilling the operation of the equipments in a project. In addition, if the circuit have some problems, the microcontroller can identify those problems in analyzing physical implementation of the circuit during debugging process.

3.3 Arduino

An Arduino is a microcontroller motherboard that can run one program at a time, over and over again and it is easy to use comparing to the Programmable Logic Controller (PLC) and Raspberry Pi.An Arduino board is best used for simple repetitive tasks such as opening and closing a garage door. This is the assumption of the functionality of the Arduino in this project. First, the user inputs the amount of the ingredient that they need and uploads the command to the Arduino. Then a shutter will be open which allows the ingredient to flow out following the amount of ingredient that the user wanted. After a certain point when the requested amount has been dispensed, the shutter will automatically close back which stops the flowing process.

3.3.1 Arduino Software

The Arduino Software (IDE) can be easily to install and runs on Windows which makes it easier to write code and upload it to the Arduino board. This software as shown in Figure 3.3.1 is one of the examples of the Arduino Software (IDE). The environment of this software is written in Java and it is based on processing and other open source software.

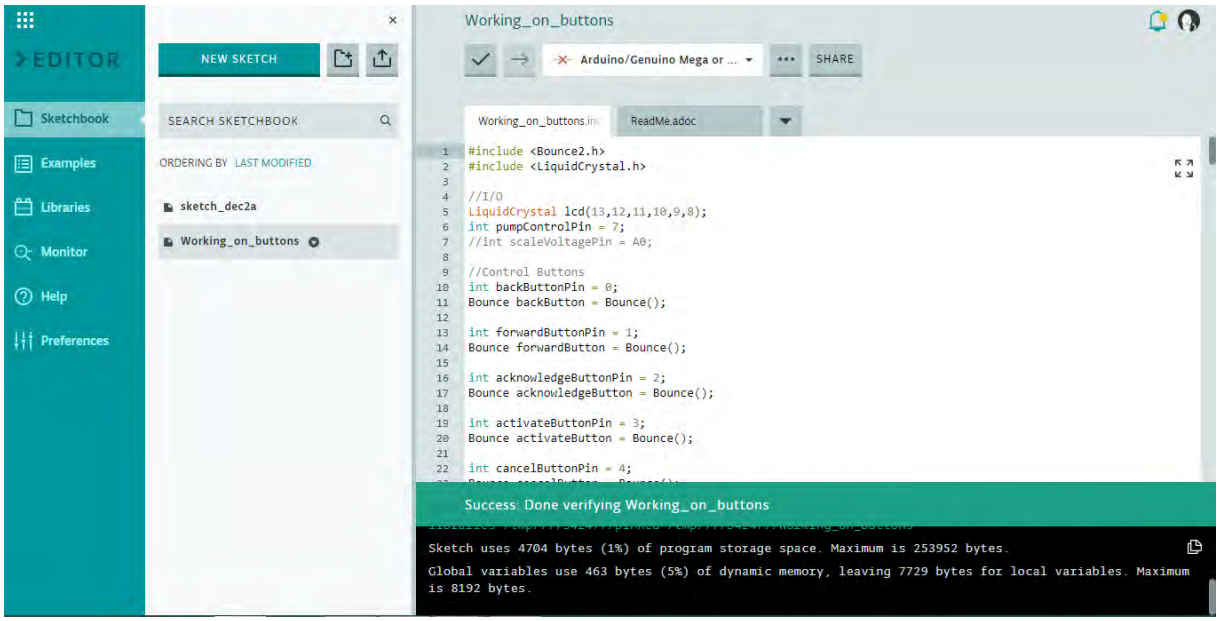


Figure 3.3.1 : Arduino Software

3.4 Analytical study

In this project, two equations which are the Bernoulli equation and the Fluid Volumetric Flow Rate equation will be use to evaluate the quantity of fluid ingredient (Neera) flow out from the container with respect to the density of the Neera, the time for the opening valve and the diameter of the valve of the container. In figure 3.4, v_1 and h_1 is constant due to their initial value. P_2 at the end of the valve where the exposure to the atmosphere occur can be conclude as an atmosphere pressure, P_{atm} where the value is neglectable.

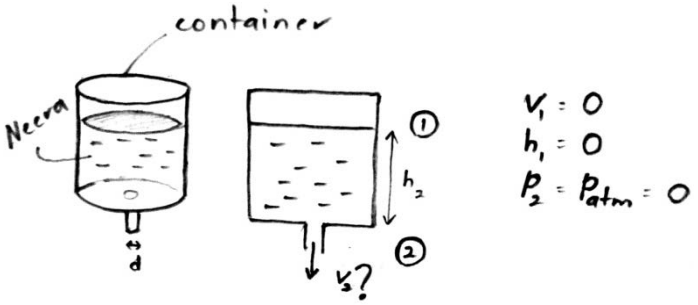


Figure 3.4 : Container Ingredient Dispenser

This study will use the Bernoulli equation to find the velocity, v_2, of the fluid ingredient flow in order to find the quantity of the fluid ingredient, ΔV, flow out using the Fluid Volumetric Flow Rate equation.

Bernoulli equation:

$$P_1 + \frac{1}{2}pv_1^2 + pgh_1 = P_2 + \frac{1}{2}pv_2 + pgh_2 \quad (1)$$

$$v_2 = \frac{P_1 - pgh_2}{\frac{1}{2}p} \quad (2)$$

Area of cylinder:

$$A = 2\pi rh \quad (3)$$

Fluid Volumetric Flow Rate equation:

$$Q = vA = \frac{\Delta V}{\Delta t} \quad (4)$$

$$\Delta V = vA\Delta t \quad (5)$$

3.5 Flow Chart

The Appendix A below shows the flow chart of methodology FYP 1. Flow Chart is used to show the progression of the project from the beginning until finishing. By refering and following to the flow chart, the work in finishing this project will be done smoothly.

3.6 Making Survey

The Survey method is use in this project in order to gather the data by asking questionaire to people who are thought to have desired information on the design engineering course. The questionaire is prepared formally and approached digitally. The result obtained will be use as a guide in producing a better product. There are 7 questions that have been made regarding the concept design of the ingredient dispenser. 32 reponses have been collected and most of these responses are mostly students faculty of mechanical engineering and faculty of engineering technology which is suitable in evaluating this product.

Arduino based system for ingredient dispensing in palm sugar (Gula Melaka) production

Arduino in ingredient dispensing in Gula Melaka production is something that should be develop in today industrial production presently due to their programmable functions that provide common control in the machine in performing defined task. The reason being is because the industry of Gula Melaka still heavilly relies on manpower in their production system. Hence, by installing Arduino based system, the improvement in the Gula Melaka production system can be achieved. Other than fulfilling the production requirement, the Arduino based system can also reduce the laborwork.

Laborwork in Gula Melaka production

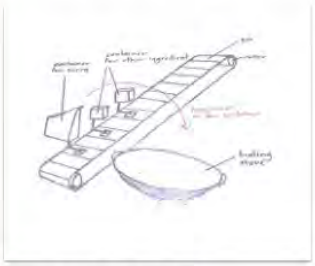
1. Do you agree in the development of this idea to install an automated Arduino based system in Gula Melaka Production?

- ○ Yes
- ○ No

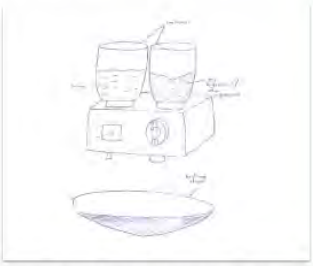
2. Do you think the design of the Gula Melaka ingredient dispenser is importance in this development?

- ○ Yes
- ○ No

3. Which of this design is more innovative?



○ Option 1 : Treadmill Automated Ingredient Dispenser Design



○ Option 2 : Manual Ingredient Dispenser

Option 3 : Push Button Automated Ingredient Dispenser

4. In this development, what criteria do you think is important?

1 = Least Important 5 = Most Important

	1	2	3	4	5
SIMPLE OPERATION	○	○	○	○	○
COST EFFECTIVENESS	○	○	○	○	○
TEMPERATURE RESISTANT	○	○	○	○	○
PORTABLE CAPABILITY	○	○	○	○	○
EASY MAINTENANCE	○	○	○	○	○
HIGH DURABILITY	○	○	○	○	○
HIGH LIFE SPAN	○	○	○	○	○
SAFETY FEATURE	○	○	○	○	○

5. Do you agree that this development will bring good impact in the future?

- ○ Yes
- ○ No
- ○ Maybe

6. Do you think this Gula Melaka ingredient dispenser can be use for other purposes? Describe your answer.

Your answer

7. Do you have any suggestion in improving this development? Explain

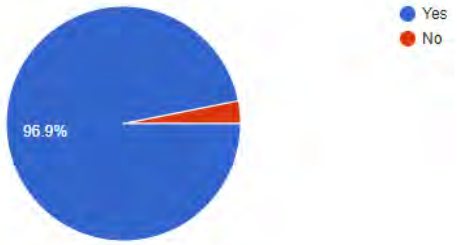
Your answer

Figure 3.6(a) : Survey Sample

3.4.1 Respondes

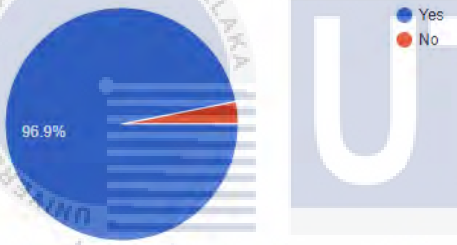
1. Do you agree in the development of this idea to install an automated Arduino based system in Gula Melaka Production?

32 responses



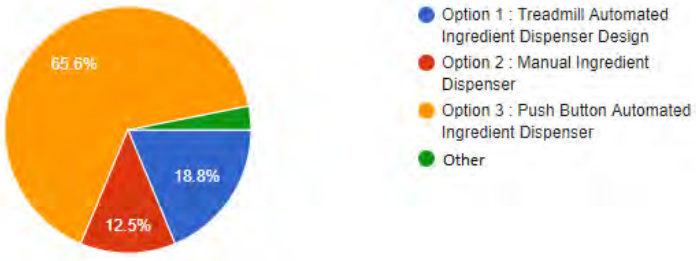
2. Do you think the design of the Gula Melaka ingredient dispenser is importance in this development?

32 responses

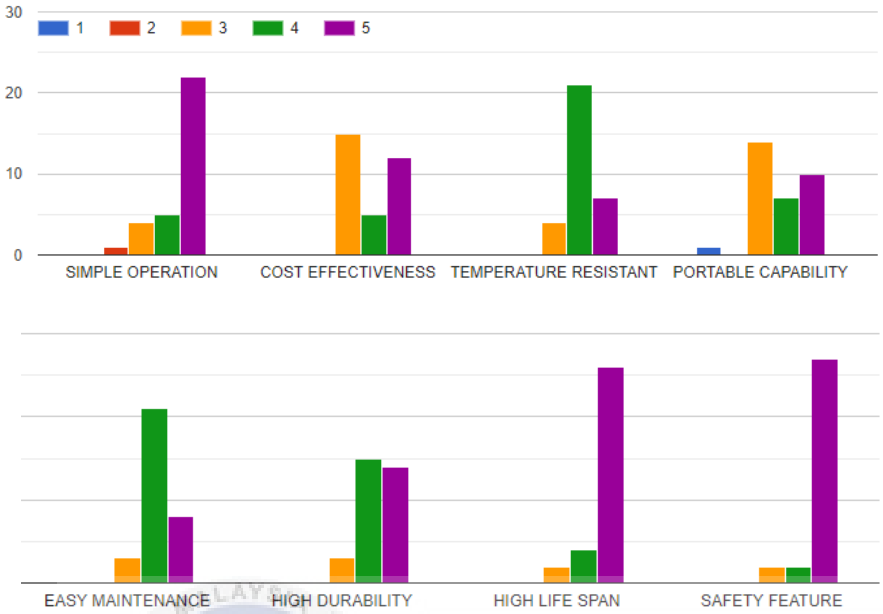


3. Which of this design is more innovative?

32 responses

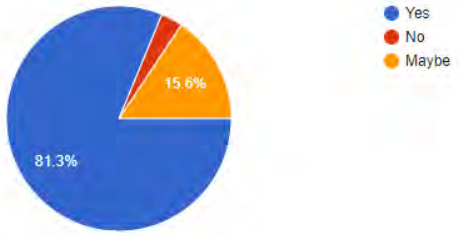


4. In this development, what criteria do you think is important?



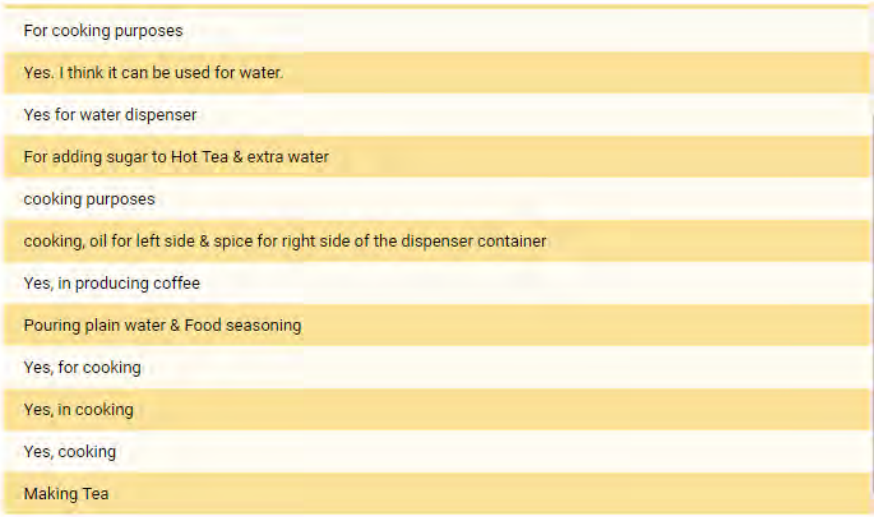
5. Do you agree that this development will bring good impact in the future?

32 responses



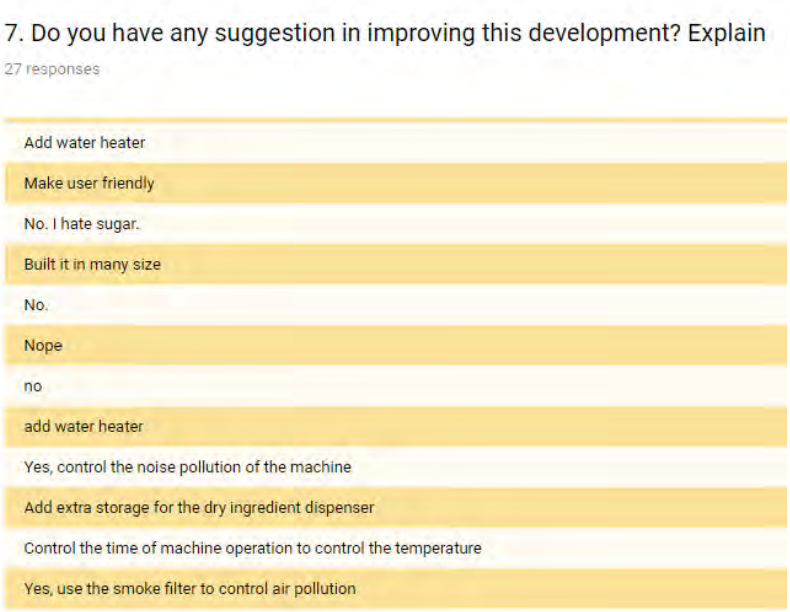
6. Do you think this Gula Melaka ingredient dispenser can be use for other purposes? Describe your answer.

27 responses



Useful answers

- Cooking purposes, oil for left side and spice for right side of the dispenser container
- Coffee production
- Making tea
- For adding sugar and extra water
- Pouring plain water and food seasoning



Useful answers

- Add water heater
- Make user friendly
- Built in many size
- Yes, control the noise pollution of the machine
- Add extra storage for the dry ingredient dispenser

Figure 3.6(b) : Data of the questionaire

3.7 House of Quality (HOQ)

In table 3.7 below represent the House of Quality (HOQ) which summarize the relation between the customer requirements to the engineering characteristics. The house of quality also known as the first matrix in four-phase QFD (Quality Function Deployment) process. The correlation matrix in the house of quality evaluates how the defined product specifications optimize or sub-optimize each other. Through the house of quality, the identification on what the customer requirements and what is engineering characteristics show in table below.

PROJECT TITLE:
ARDUINO BASED SYSTEM FOR INGREDIENT DISPENSING IN GULA MELAKA PRODUCTION

9	Strong relationship
3	Medium relationship
1	Weak relationship

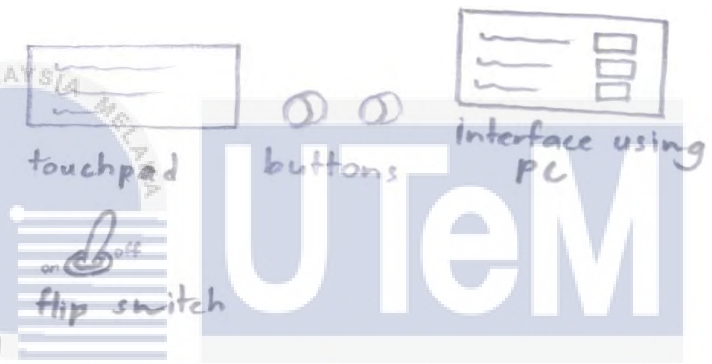
DIRECTION OF IMPROVEMENTS										
ENGINEERING CHARACTERISTICS / CUSTOMER REQUIREMENTS		CUSTOMER IMPORTANCE	DESIGN	SIZE	STRENGTH	WEIGHT	MATERIAL	ACCURACY	AUTOMATED SYSTEM	RELIABILITY	
	SIMPLE OPERATION	5	9	3		9		9	9	9	
	COST EFFECTIVENESS	3	9	3	3	1	9	9	9	9	
	TEMPERATURE RESISTANT	4	1		9		9			9	
	PORTABLE CAPABILITY	3	3	9		9	3			3	
	EASY MAINTENANCE	4	9	9		3	9	9	9	9	
	HIGH DURABILITY	4	3		9		9			9	
	HIGH LIFE SPAN	5			9		9		9	9	
	SAFETY FEATURE	5	9		1	3	3		9	9	
	TECHNICAL PRIORITIES (SCORE)		178	87	131	102	204	108	198	279	1287
	PERCENTAGE OF TOTAL (%)		13.8	6.8	10.2	7.9	15.9	8.4	15.4	21.7	
	RANK		4	8	5	7	2	6	3	1	

Table 3.7 : House of Quality (HOQ)

3.8 Morphological Analysis

Table 3.8.1 below shows the Morphological Chart for the concept design of the project. Based on Morphology Chart, three different concepts for the final design product was generate. Each design was generated with different components which will be describe further in concept design sketch.

3.8.1 Morphological Chart

USER INTERFACE FOR INPUT	
MICROCONTROLLER MOTHERBOARD	Raspberry Pi Arduino PLC
FLOW CONTROLLER OF INGREDIENT	

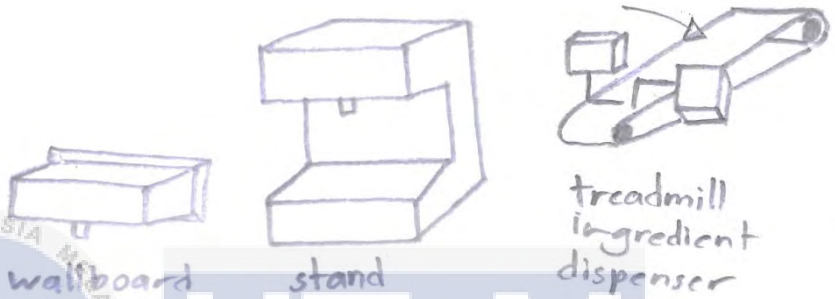
CONTAINER TO STORE INGREDIENTS	
INGREDIENT DISPENSER BODY	
POWER SOURCE	

Table 3.8.1 : Morphological Chart

3.9 Concept Generation

3.9.1 Funtional Decomposition

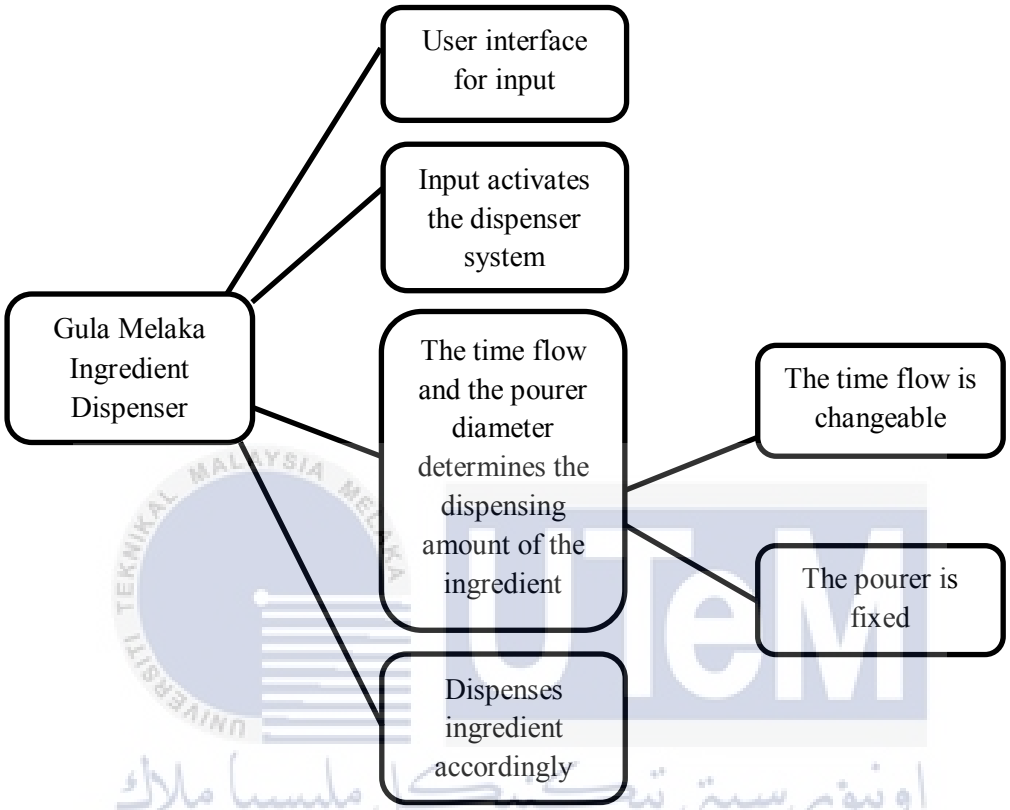


Figure 3.9.1 : Funtional Decomposition

3.9.2Concept Design Sketches

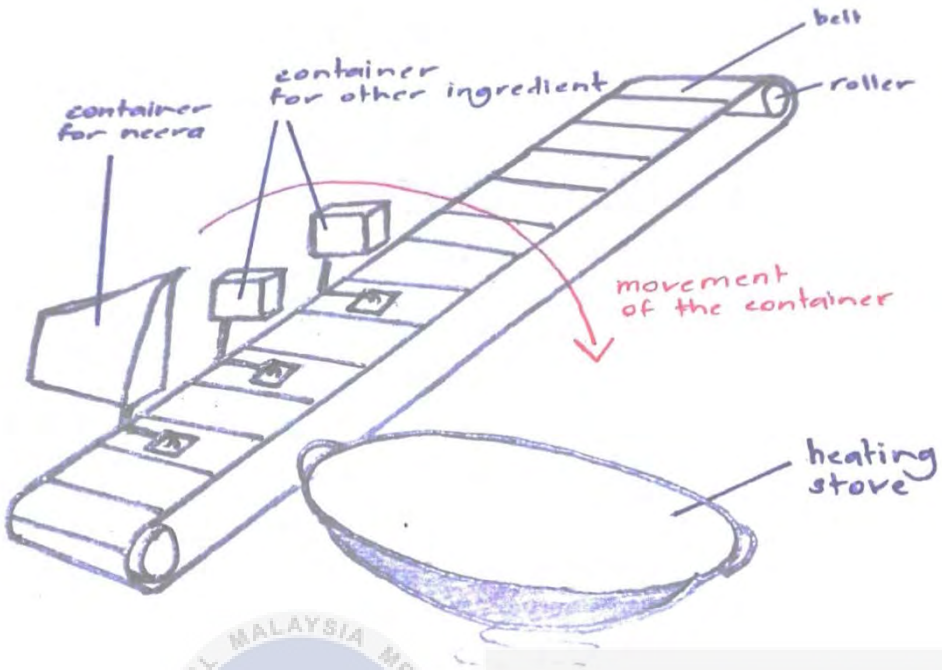


Figure 3.9.2 : Concept Design 1

Name: "Treadmill Automated Ingredient Dispenser Design"

Description: This ingredient dispenser has multiple containers where the first container is specifically for Neera and the other containersare for other additional ingredient. The flow of the ingredient is control by the treadmill where it contains a belt and two rollers. The roller rotates by a motor which controls the rotation of the treadmill. The ingredient dispenses by rotates the container toward the heating store one by one accordingly controlled. The system of this ingredient dispenser is automated by using Arduino based system that controls the operation of the treadmill and the rotation of the containers.

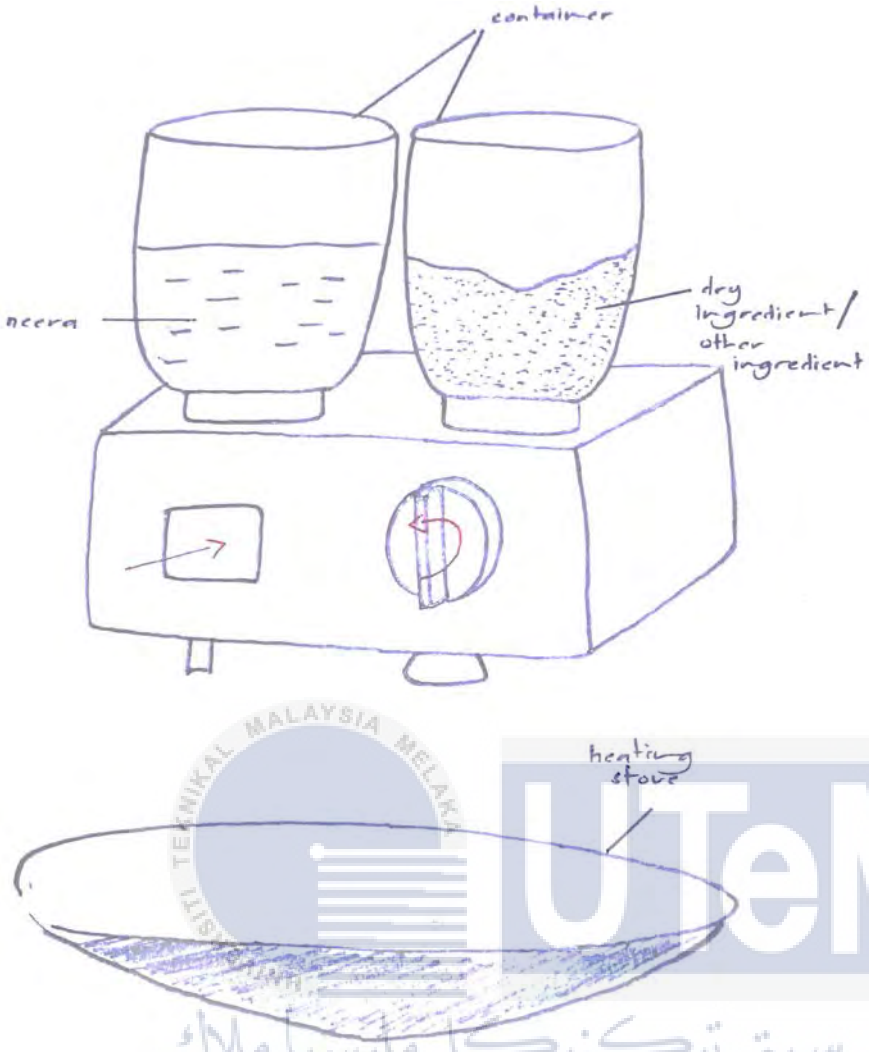


Figure 3.9.2(b) : Concept Design 2

Name: "Wallboard Manual Ingredient Dispenser"

Description: This ingredient dispenser has two containers, left container is for Neera, right is for additional dry ingredient or other ingredients. The containers that installed in this ingredient dispenser is the one-opening jar. The system is manually controlled which the amount of ingredient dispenses are fully depends on the user. The Neera dispenses by pushing the button that open a valve for the Neera to flow into the heating stove. The dry ingredient dispense by rotate the manual cam which push the dry ingredient to be dispensedconsistently according to the user.

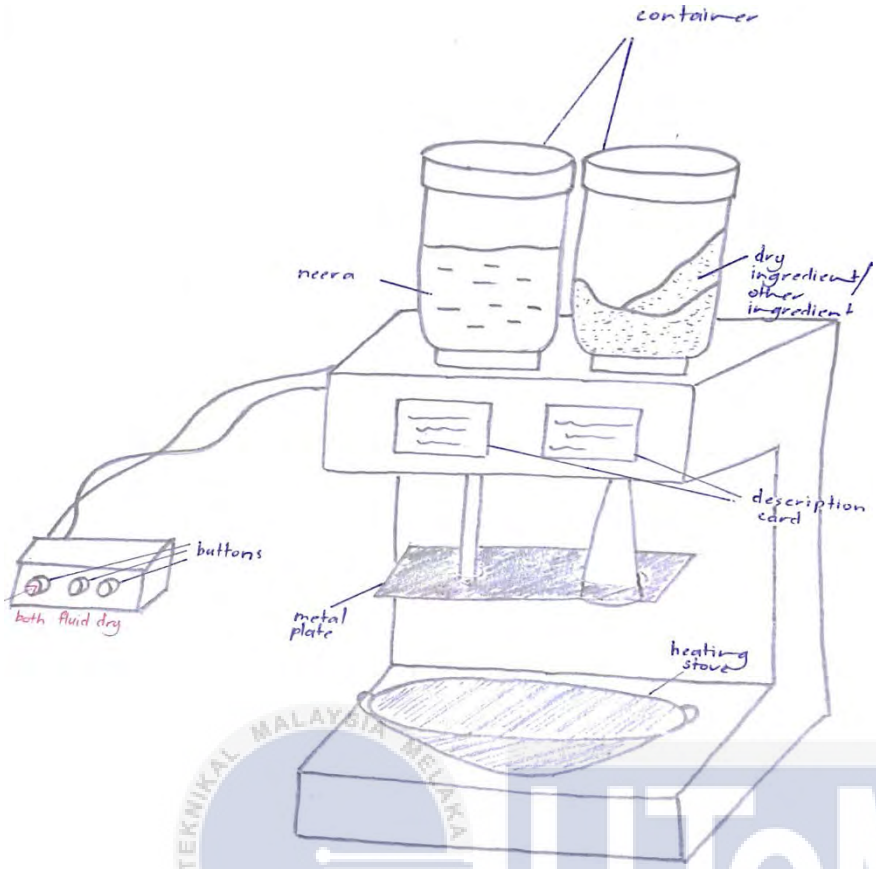


Figure 3.9.2(c) : Concept Design 3

Name: "Push Button Automated Ingredient Dispenser"

Description: This ingredient dispenser contains two containers which the left container is specially for the Neera and the right container is for the dry ingredient or other ingredients. The containers that installed in this ingredient dispenser is the two-opening jar which makes it easier for the containers to be refilled. The system of this ingredient dispenser is automated by using Arduino based system that controls the flow of ingredient dispenser where the user interface input is determine by pushing a button.There are three buttons installed in this ingredient dispenser which controls double flow or single flow of the ingredient dispenser. The Neera dispenses by opening a valve for the Neera to flow into the heating stove. The dry ingredient dispense by the automated cam rotating which push the dry ingredient to be dispensed consistently.

3.10 Concept Scoring and Screening

3.10.1 The Pugh Concept Selection

For concept evaluation, Pugh method or Pugh concept selection also known as the weight decision matrix method is used for evaluate where it is use to rank the multi-dimensional options of an option set using qualitative technique. It is also represent as a tool used for the comparison of the alternatives with respect to multiple criteria of different levels of importance. This method often used in engineering for making design decisions. However, it can also be used to rank all the alternatives relative to a "fixed" reference or called a datum and thus create a partial order for the alternatives.

Based on table 3.10.2 below, as the criteria from the data survey, eight customer requirements was chosen specifically focusing on question No. 4 where the data from the question was use for the weight factor. In rating evaluation, for the importance weight column, we rated from the highest percentages to the lowest percentage needed by customers, and for the rating column, we rated based on value 6-10 which is inadequate, weak, satisfactory, good, excellent as shown in table 3.10.1 below.

6-10 POINT SCALE	DESCRIPTION
6	Inadequate
7	Weak
8	Satisfactory
9	Good
10	Excellent

Table 3.10.1 : 6-10 Point Scale

3.10.2 Weighted Desicion Matrix

DESIGN CRITERION	WEIGHT FACTOR	UNIT	Concept 1			Concept 2			Concept 3		
			A	B	C	A	B	C	A	B	C
SIMPLE OPERATION	0.13	EXP	Weak	7	0.91	Good	9	1.17	Excelent	10	1.3
COST EFFECTIVENESS	0.115	RM	350	6	0.69	150	10	1.15	200	8	0.92
TEMPERATURE RESISTENT	0.12	EXP	Satisfactory	8	0.96	Weak	7	0.84	Good	9	1.08
PORTABLE CAPABILITY	0.11	EXP	Weak	7	0.77	Weak	7	0.77	Excelent	10	1.1
EASY MAINTENANCE	0.125	EXP	Weak	7	0.875	Satisfactory	8	1.0	Satisfactory	8	1.0
HIGH DURABILITY	0.128	EXP	Satisfactory	8	1.024	Weak	7	0.896	Good	9	1.152
HIGH LIFE SPAN	0.135	EXP	Satisfactory	8	1.08	Weak	7	0.945	Good	9	1.215
SAFETY FEATURE	0.137	EXP	Inadequate	6	0.822	Excelent	10	1.37	Excelent	10	1.37
TOTAL			**7.131**			**8.141**			**9.137**		

HINTS: **A – Magnitude** **B – Score** **C – Rating**

Table 3.10.2 : Weighted Desicion Matrix

3.11 Final Decision Selection

Concept Design #3

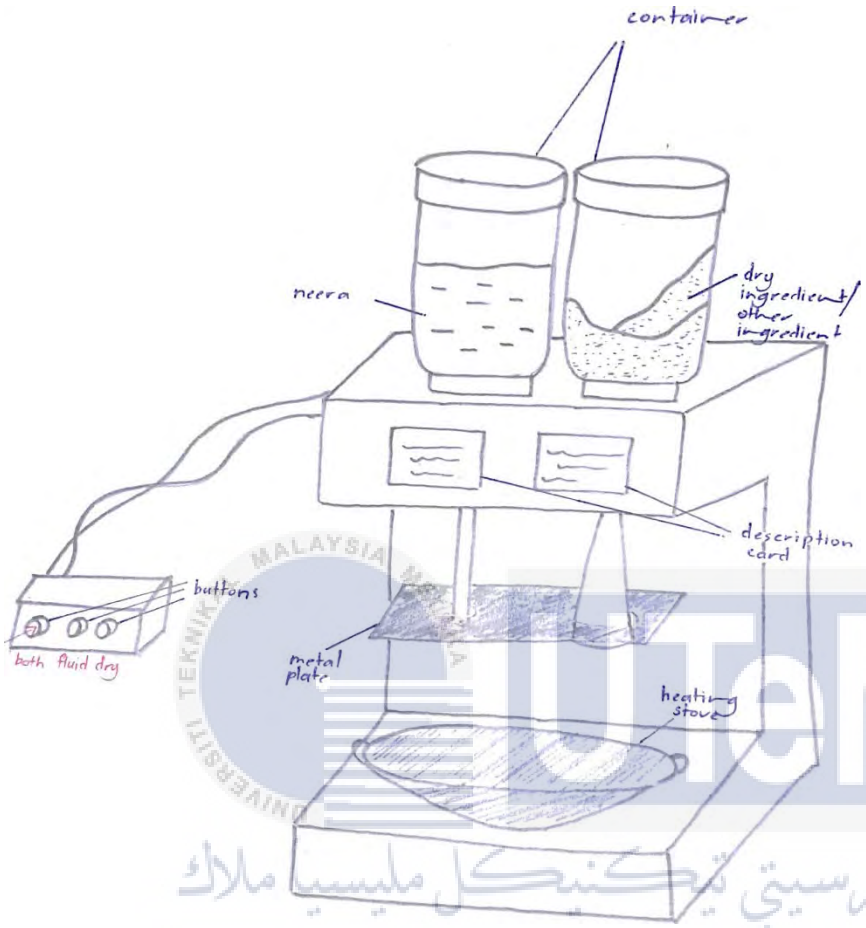


Figure 3.11 : Final Decision Selection

Based on the Concept Scoring and Screening method selection, the finest concept design for the the ingredient dispenser with Arduino based system is Concept Design #3 which has highest final score as shown in the Appendix C above. In comparison for the simple operation, concept design 3 get the highest score due to the push button functionality with the support from the Arduino based system where the user only need to push a button for the ingredient to be dispense. For the cost-effectiveness, concept design 3 get a moderate score compared to concept design 2 which has the highest score because of the lowest price that assume to cost for only RM150.00. The temperature for the concept design 3 is

the highest because the design includes the metal plate that block the temperature flow from the heating stove to flow across which can bring damages to the ingredient dispenser. The concept design 3 is easy to be portable due to the simple water dispenser design compared to the other design where the concept design 1 is complicated because of the treadmill machinery design and the concept design 2 is also troublesome for the undetachable wallboard function that can only be use once permanently. For the easy maintenance, the concept design 3 get a moderate score because of the complexity in reprogramming the Arduino based system. The high durability and the high life span of the concept design 3 score the highest also because of the metal plate. Lastly is the safety feature, where the concept design 3 score the highest due to the distance of the user interface and the machinery which purposely to keep the user safe from any harms away from the heating stove.

3.12 Component Selection

Automated Arduino based system:

- 1 Arduino Mega (or equivalent)
- 1 Potentiometer
- 3 buttons
- 5 resistors
- Jumper wires

Fluid Ingredient Dispensing:

- 1 plastic shutter

Powder Dispensing:

- 1 stepper motor

Body of the ingredient dispenser:

- Wooden pieces
- 1 metal plate
- 2 containers
- Glue
- Screws
- 4 fixed staple hasp

3.13 Cost Analysis

This table 3.13 below will briefly explain the cost estimation of this project. In order to design and manufacture the product, the cost of this whole product can be achieved by the estimation on the costing of each components.

No.	COMPONENTS	UNIT	PRICE (RM)	TOTAL (RM)
1.	Arduino Mega	1	50.00	50.00
2.	Potentiometer	1	8.00	8.00
3.	Button	3	2.00	6.00
4.	Resistors	5	0.40	2.00
5.	Jumper wires	1	5.00	5.00
6.	Plastic shutter	1	0.00	0.00
7.	Stepper motor	1	50.00	50.00
8.	Wooden Pieces	7	0.00	0.00
9.	Metal Plate	1	5.00	5.00
10.	Plastic container	2	5.00	10.00
11.	Screws	10	0.50	5.00
12.	Glue	1	8.00	8.00
13.	Fixed staple hasp	4	10.00	40.00
Total				189.00

Table 3.13 : Cost Analysis

3.14 Catia

Catia is a CAD (Computer-Aided Design) tool that can be used for different design stages where the user can draw their concepts design, modify them, simulate them, identify problems and finally proceed them into the production. Catia has different type of modules such as Part design, Surface design, Assembly design, Composite Structure design, Sheet metal design and much more. For this Project, Part design will be use to describe the detail designing and colouring of the concept design. Figure 3.14 show the Part design model of the concept design.

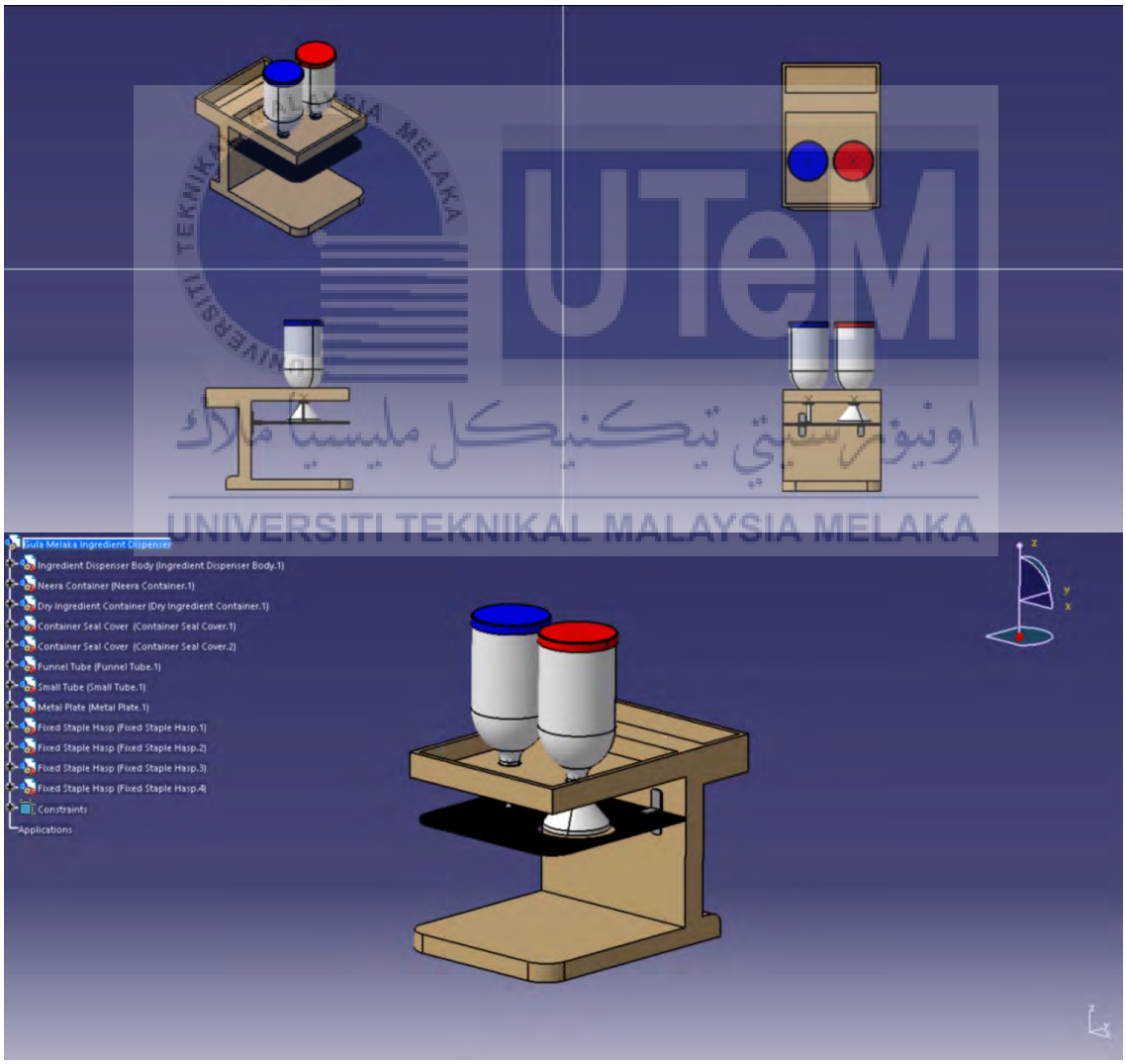


Figure 3.14 : Catia

3.15 Gant Chart

A Gantt chart is a chart that illustrates a project schedule where liststhe tasks to be performed on the vertical axis, and time intervals on the horizontal axis. The width of the horizontal bars in the chart shows the duration of each activity showing the progression in finishing the project which concludes the time approximation to obtain each of the activities and also time estimation taken to complete the whole proces. Usually, Gant chat are created initially before starting a project. Gant chat is very important in knowing beforehand on how the progression of a project will be set up. Appendix B shows the Gantt chart for this FYP 1 project time period.

3.16 Conclusion

In conclusion, this project is mainly focusing on improving the ingredient dispensing method in palm sugar production compared to the traditional method in Malaysia. In order to achieve this goal, this project uses Arduino Mega in developing an automated Arduino based system for the ingredient dispensing process of the palm sugar production. In this new method, the user only need to push a button to dispense the required amount of the ingredient. This new method will also be focusing on the design of the ingredient dispensing model which will also aim to improve the system by reducing the laborwork in the palm sugar production.

References

[1] YOSHITAKA SHIOTSU, "AN INTRODUCTION TO ARDUINO." [Online]. Available: https://www.upwork.com/hiring/development/an-introduction-to-arduino/. [Accessed: 25-Oct-2018].

[2] N. HEALTH, "ARDUINO CHEAT SHEET." [Online]. Available: https://www.techrepublic.com/article/arduino-the-smart-persons-guide/. [Accessed: 25-Oct-2018].

[3] ROBYN ECKHARDT, "CONFESSIONS OF A PALM SUGAR ADDICT." [Online]. Available: https://www.saveur.com/palm-sugar-malaysian-gula-melaka-recipes. [Accessed: 25-Oct-2018].

[4] ANDREW LOH, "MALACCA REMINISCENCES." [Online]. Available: https://books.google.com.my/books?id=4q1OCwAAQBAJ&pg=PT254&lpg=PT254&dq=palm+sugar+Andrew+Loh&source=bl&ots=HFz5wIQbT2&sig=cpF208jheUuYaYm0PwNYWmj8YvY&hl=en&sa=X&ved=2ahUKEwiJt47ZtaHeAhWGV30KHX23CVgQ6AEwDXoECAkQAQ#v=onepage&q=palm sugar Andrew Loh&f=false. [Accessed: 25-Oct-2018].

[5] N. P. Mahalik and A. N. Nambiar, "Trends in food packaging and manufacturing systems and technology," *Trends Food Sci. Technol.*, vol. 21, no. 3, pp. 117–128, 2010.

[6] K. A. Azlan, H. Zainuddin, and F. R. Ramli, "Design of semi-auto line for gula Melaka processing Design of semi-auto line for gula Melaka processing," no. January, 2015.

[7] K. D. McCranie, M. Faulkner, D. French, G. A. Daddis, J. Gow, and A. Long, "Design and Testing of Automation Control for Mini Gula Melaka Production System using Arduino," *J. Strateg. Stud.*, vol. 34, no. 2, pp. 281–293, 2011.

[8] P. Naknean, M. Meenune, and G. Roudaut, "Changes in properties of palm sugar syrup produced by an open pan and a vacuum evaporator during storage," *Int. Food Res. J.*, vol. 20, no. 5, pp. 2323–2334, 2013.

[9] 1Alwia Usman, 3 2Agus Suman, and 4Wahib Muhaimin Luchman Hakim, "The Impact of Home-Based Business Processing Palm Sugar to Increase Socio-Economic Welfare of Farmers In South Halmahera Regency\n," *IOSR J. Bus. Manag.*, vol. 16, no. 11, pp. 32–37, 2014.

[10] P. S. A. Silva and A. Bamunuarachchi, "Asian journal of food and agro-industry AJOFAI.," *Asian J. Food Agro-Industry*, vol. 2, no. 2, pp. 210–213, 2008.

[11] R. Hasan *et al.*, "Development of innovation in Malaysian traditional palm sugar cooking machine," *Proc. Mech. Eng. Res. Day 2015*, no. March, pp. 143–144, 2015.

[12] H. Aripin *et al.*, "Automated Temperature Control with Adjusting Outlet Valve of Fuel in the Process of Cooking Palm Sugar," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 336, no. 1, 2018.

[13] A. Iskandar, I. Yuliasih, and D. B. Haryanto, "Effect of Temperature and Time on Dry Granulation Process of Arenga Palm Sugar," *Int. J. Res. Eng. Technol.*, vol. 2, no. 9, pp. 2321–8843, 2014.

[14] D. Karamoko, N. Théodore Deni, J.-L. Aboya Moroh, K. M. Jean-Paul Bouatenin, and K. M. Dje, "Biochemical and Microbial Properties of Palm Wine: Effect of Tapping Length and Varietal Differences," *Food Nutr. Sci.*, vol. 07, no. 09, pp. 763–

771, 2016.

[15] F. Reverter, *Interfacing sensors to microcontrollers: A direct approach*, vol. 1. Elsevier Ltd, 2018.

[16] V. Hoxha, I. Bula, M. Shala, and E. Hajrizi, "Cost-Oriented Open Source Automation Potential Application in Industrial Control Applications," *IFAC-PapersOnLine*, vol. 49, no. 29, pp. 212–214, 2016.

[17] J. A. Rossiter, "Using online lectures to support student learning of control engineering," *IFAC Proc. Vol.*, vol. 10, no. PART 1, pp. 132–137, 2013.

[18] N. Caywood and N. T. Wojciechowsi, "Dry Ingredient Dispenser , Group S , 2017," 2017.

[19] C. J. Huang and F. T. Tsai, "Research and Development of a Practical Water Dispenser," pp. 1225–1228, 2017.

[20] C. GILBERT, "WHAT ARE SOME SUBSTITUTES FOR PALM SUGAR." [Online]. Available: https://www.quora.com/What-are-some-substitutes-for-palm-sugar-How-do-these-substitutes-affect-the-taste. [Accessed: 30-Nov-2018].

[21] B. Misra, "Neera : The coconut sap : A review," vol. 1, no. 4, pp. 35–38, 2016.

[22] D. K. Ghosh, A. Bandyopadhyay, S. Das, K. B. Hebbar, and B. Biswas, "Coconut Sap (Neera) - Untapped Opportunity of Spinoff Gains in West Bengal , India," vol. 7, no. 09, pp. 1883–1897, 2018.

[23] R. A. Serway, "Bernoulli's equation says that the sum of the pressure, P, the kinetic energy per unit 1 volume (," *Saunders Coll. Publ.*, vol. 1, pp. 422–434, 1996.

[24] D. V. R. Ismail Hussain, "A study on the significance of Bernoulli's equation in

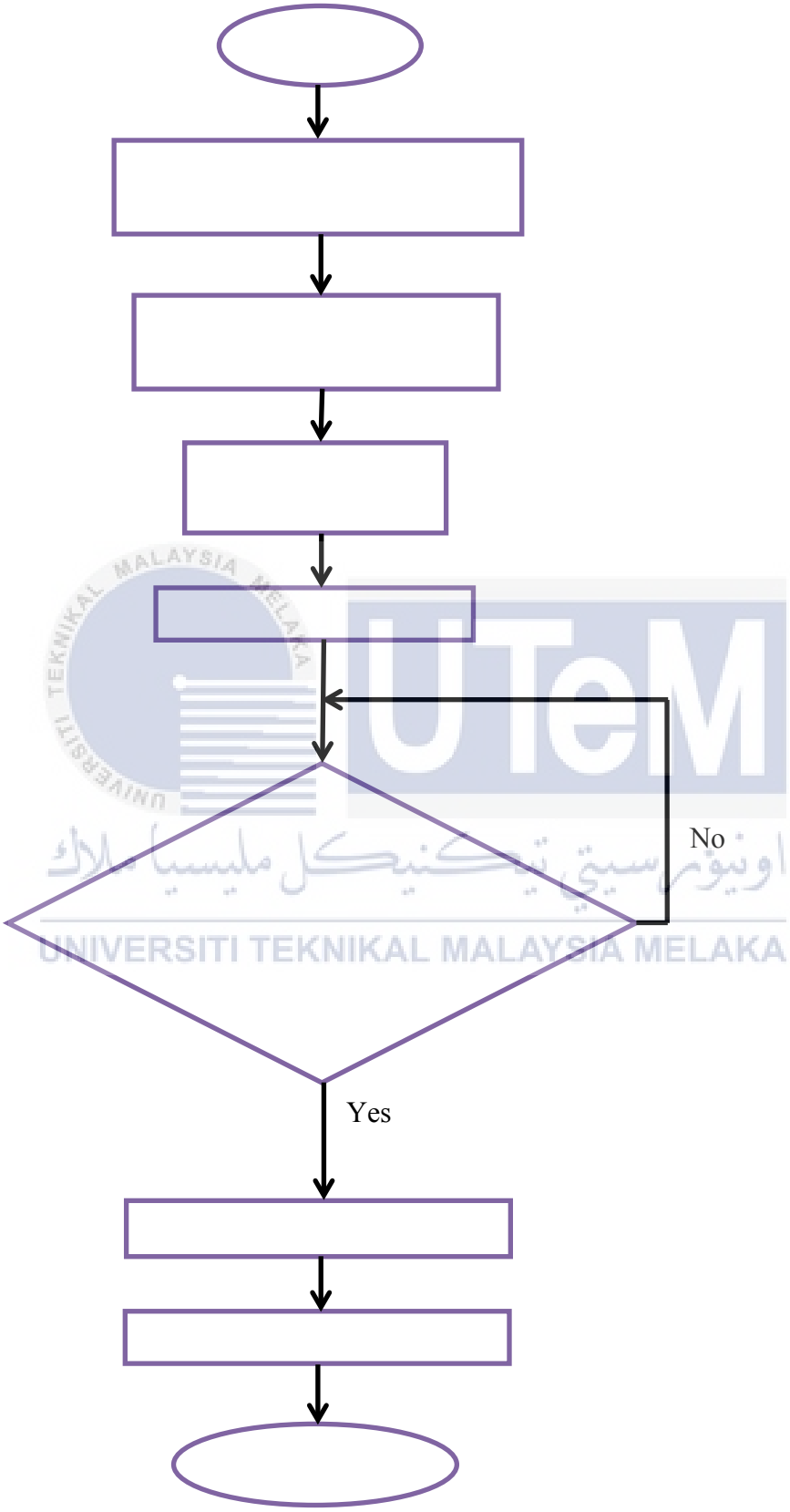
fluid dynamics Ismail," vol. 2, no. 12, pp. 82–86, 2016.

[25] M. Towhiduzzaman, "Performance Analysis of Continuity Equation and Its Applications," vol. 1, no. 5, pp. 40–43, 2016.

[26] Y. Nakayama, "Fluid Mechanics."

APPENDICES

Appendix A



Appendix B

Activities	Week															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Brainstorming and discussing for the selection of the title																
Meeting session with supervisor																
Chapter 1: Introduction																
Chapter 2: Literature review																
References: Article, journal or web page																
Submission progress report 1																
Chapter 3: Methodology																
Submission of general conduct form and logbook to supervisor																
Submission of the Draft Final Report PSM 1 to supervisor and examiners.																
Poster project presentation																
Seminar PSM 1																