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Design and Fabrication of Customized *Ais Kacang* Vending Machine

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ABSTRACT

Nowadays, machines play a critical role as those machines are broadly utilized in various subjects. The contribution of machines is swiftly growing day by day as they are starting to replace humans in everyday tasks. The machine is also used for the food and beverage industry to deliver the products easily and conveniently to customers. This paper focuses on the design and fabrication of the customized *Ais Kacang* vending machine for canteen, cafeteria and restaurant usage. There were five designs made and one best conceptual design was selected by using a ranking method. In addition, this paper explains the stress and strain analyses of the internal frame of the vending machine. The *Ais Kacang* vending machine has been undergone two tests, the geometrical and final product tests. The selected machine was able to produce a plate of *Ais Kacang* in 66 seconds using auto mode. However, the time needed to produce a plate of *Ais Kacang* in manual mode depended on the user.

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1. INTRODUCTION

The contribution of machines in our daily lives is swiftly growing day by day as they are starting to replace humans in everyday tasks. Machines can do tasks that might either be impossible for an individual to do or it might take a longer time for them to complete it. Accordingly, machines make human's work easier and more effective.

The feature of machines can be similarly improved by giving imaginative and prescient to the function. In the food and beverage industry, a vending machine is used to deliver the products easily and conveniently to customers.

In the vending machine, the order placed by a customer is input data for the machine. As a result, at the end of the process, the customer obtains the re-

quested product from the machine. This is the general operation of the vending machine from start to end. The vending machines can be designed for specific functions like for beverages, food or other items. The vending machines offer portability, low cost, comfort, and also use less space for putting in place and can be installed in 24/7 service places. Vending machines mentioned in past studies were based on CMOS, SED and Microcontroller's technology. The vending machine culture is antique as in line with the history. The first vending machine was used in 2-3 B.C. in Egypt. It was a mechanical machine to sell water in Egypt. Then, vending machines with numerous features were used at some stages in the economic revolution in the United Kingdom in the 19th century. The first-ever commercialized vending machine was for postcards, which might have been used coins, was introduced in London.

A vending machine is an automatic machine that offers items including snacks, drinks, cigarettes and lottery tickets to consumers after money, a credit card, or a mainly designed card is inserted into the device. The primary modern vending machines had been developed in England within the early 1880s to distribute postcards (Higuchi, 2007). Vending machines exist in many nations, and the latest ones now are the specialized vending machines that provide less commonplace products compared to standard vending machine objects that were created and provided to consumers. Smart vending machines have been introduced but usage in Malaysia is very less compared to other countries like Japan, the United States, and Germany (Raposo *et al*., 2015).

This paper focuses on the design and fabrication of the customized Ais Kacang vending machine for canteen, cafeteria and restaurant usage. This Ais Kacang vending machine will have a lot of options for consumers and it could be a new breakthrough for mechanical design developers all over the world to expose themselves to a more complicated area of designing.

The idea was to develop a customized Ais Kacang vending machine that can work in a freestyle manner to give user option of custom-made end products for individual who wants their macro and micro preferences, and pre-calculated Ais Kacang for the individual who does not have any preferences of the exact amount of ingredients to be added for good taste. In this paper, the design of the vending machine that versatile and easy for anybody to use will be explained.

2. METHODOLOGY

Figure 1 shows the flow of design, fabrication and testing process for the Ais Kacang vending machine.

2.1. Design process

Two designs used in this paper are known as conceptual design or architectural design. The vending machine design proposed in this paper must bridge the gap between design conception and detailed design. In this state, the design concept is expressed in various sketches with different ideas. This conceptual design can be illustrated with a functional block diagram description. In addition, the general framework is created to build the vending machine design to determine the dimensions, mechanical parts, electrical components, raw material load limits in the storage tank and physical characteristics of the Ais Kacang vending machine. The important areas of concern are the mechanical design, raw ingredient weighing system, and ingredient selection mechanism.

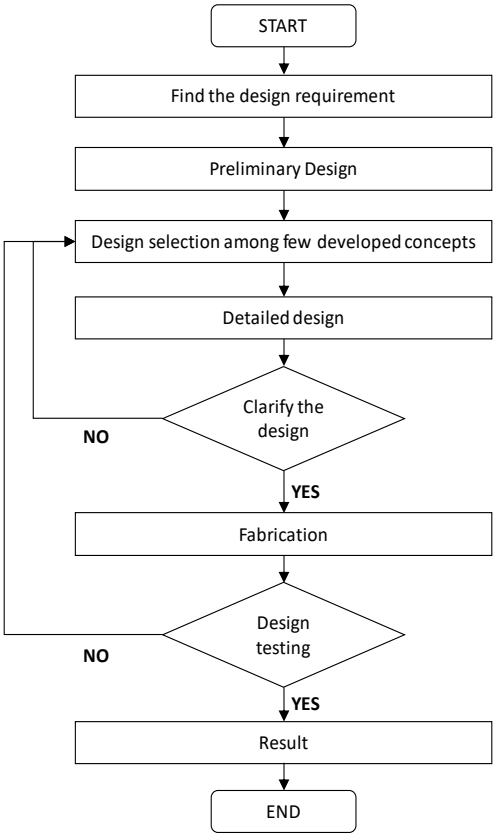


Figure 1. Flow of design, fabrication and testing process

2.2. Design selection

The design selection was conducted to select a suitable concept design to meet the project requirement for the Ais Kacang vending machine. There are five proposed concept designs with a different type of mechanical mechanism and design structure. Out of five concepts, one concept was selected by design selection. To select the suitable concept design, evaluation methods such as ranking method can be used for concept evaluation.

Firstly, a table was built with various characteristics related to the conceptual design. Subsequently, a percentage value for each criterion was given. As a guideline, the least percentage indicates poor values and the high percentage indicates the excellence of the criteria.

2.3. Detailed design

The detailed design is the lowest level in the hierarchy of design abstraction. It consists of the procurement of electrical components, mechanical parts, and materials as well. This part elaborates each aspect of the concept design by presenting a complete description.

2.4. Fabrication

Fabrication or fabricating is a process of manufacturing or creating a project. Subsequently, it is depicted as production or assembly of an item from raw, scratch or semi-finished materials. Yet, it does not involve the utilization or assembly of ready-made components or parts. In addition, fabrication can also be defined as a value-adding method, which includes inventing machines and structures.

2.5. Testing

Testing was conducted to the fully fabricated vending machine. There were two tests conducted for this vending machine. They were geometrical testing and machine final product testing. Geometrical testing was done by comparing the dimension of the fabricated machine to the dimension of the virtual design of the machine and fabricated product. Whereas, the function of the machine was tested in the final product testing.

3. RESULTS AND DISCUSSION

This section describes the result obtained based on the concept design. The machine with a suitable concept, internal structure design, fabricated and testing was selected. The outcome of the project determines whether the objectives of the mission have been achieved or not. The result of this project covers two main scopes which are design and fabrication.

3.1. Concept designs

There were five designs made as follows:

Design A uses the air compressor to operate its mechanical system (**Figure 2(a)**). There are two pneumatic pistons, named piston A and piston B. The piston A is attached to the ingredient dispenser tube and the piston B is attached to the food dispensing tray. There is a proximity sensor to detect the extension of the piston, send the signal to the system, and command to retract back the piston A. It has a lid on top of its body. Thus, it will be easier to fill in the ingredient storage tank. There is transparent glass for the user to view the working mechanical mechanism.

Design B consists of four-ingredient storage tanks as shown in **Figure 2(b)**. It uses a fixed static mechanism at one point as a set. The conveyor system brings the mug or a bowl from one place to another to fill the ingredients. It moves according to the motor rotation which makes the conveyer mat to rotate on its flow. The conveyer belt is a fence type with many tiny holes to help draining down the excessive ingredients.

Design C has two main systems (**Figure 2(c)**), the bowl dispensing and movable mechanical system. The ingredients dispenser has the y-axis and z-axis movement. All the ingredient tank tubes are connected to the middle distributor and there is a shutter type lid with a locking system. This machine body is fully covered with aluminum sheet.

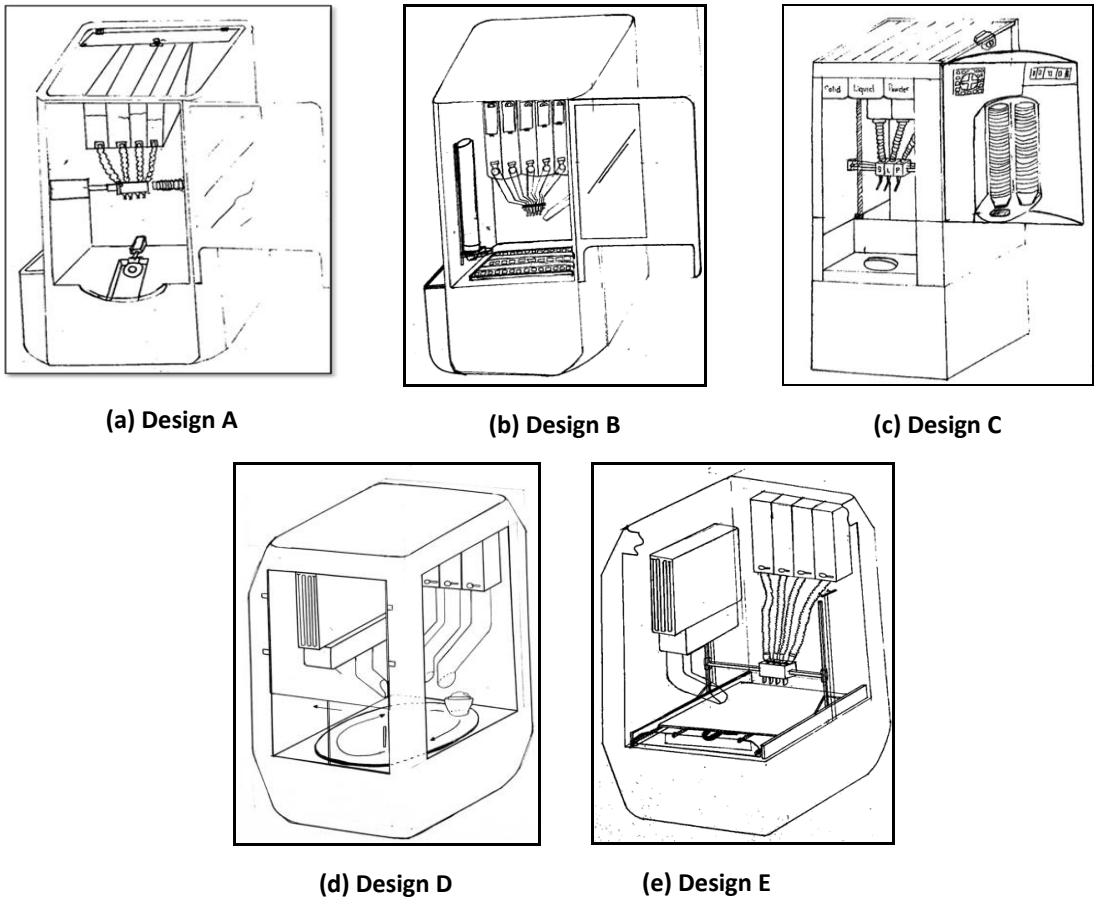
Design D has a circular platform which rotated in clockwise and anti-clockwise direction to collect the dispensing ingredients (**Figure 2(d)**).

Design E is the combination of design C and design D (**Figure 2(e)**). The mechanical mechanism is taken from the design C and the body design of the machine is taken from the design D. Design E consists four ingredient storage tank, mini freezer with blender, movable platform. This mechanism is related to 3D printer concept which has different feed mechanisms related to food products, i.e., the feed mechanisms of powder bed fusion and extrusion (Jänsch & Birkhofer, 2006; Kamran & Saxena, 2016). The movable platform operates to get a nice circular layer by layer coloring on the Ais Kacang. With this mechanism also, the user could select the ingredients based on their own preferences by selecting the option in the user interface system.

3.2. Design selection

Ranking method is one of the traditional methods to select or to make a suitable decision. According to the ranking value, concept Design E yielded the highest value since it is fulfilled almost all requirements of the project. Therefore, this

concept was selected as a project design. The final view of the Ais Kacang vending machine is shown in **Figure 3**. This machine consists of two main parts, ice storage and body. These two parts can be attached and detached from the main body of the machine. Technical specification data for this Ais Kacang vending machine is given in **Table 1**.



(a) Design A **(b) Design B** **(c) Design C**

(d) Design D **(e) Design E**

Figure 2. Conceptual Design

Figure 3. Ais Kacang Vending Machine

Table 1. Machine specification

SPECIFICATION OF VENDING MACHINE		
Accessories	Included	Plastic Bowl
Sustainability	Power consumption	120W
Weight and dimension	Dimension (W x b x ℓ)	980mm X 360mm X 360mm
	Machine Weight (with load)	42 Kg
	Ingredient container Weight (without load)	430g
	Ingredient container Weight (with load)	8.kg
Design	Colour	Blue
Technical specifications	Voltage	220-240V
	Water tank capacity	1.2ℓ per tank
	Ice storage Capacity	2kg (blended ice)
Finishing	Main Body	3mm plastic sheet
	Edge Frame	Aluminium
	Internal Frame	ASTM A36
General specification	Suitable for	Dry and liquid material
	Type of display	16x2 LCD
	Ease of use	Dual Mode
Machine capacity	Automatic mode	1 cup / 66 sec @ 55 cups /1 hour
	Manual mode	Depends on user

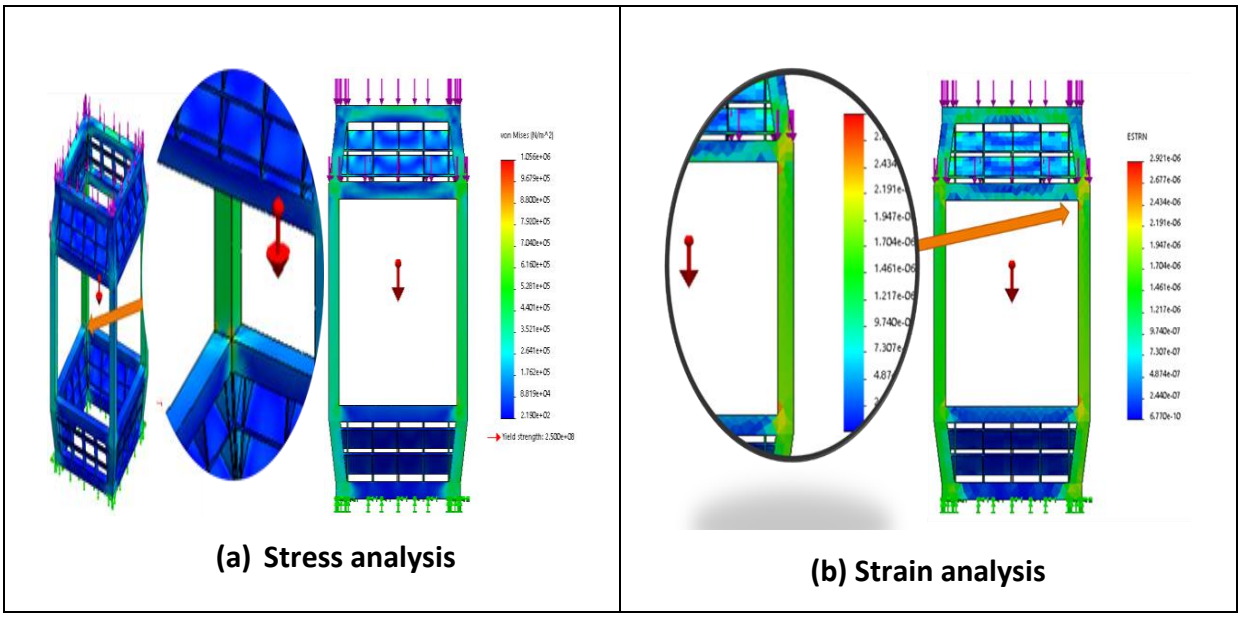
3.3. Frame Analysis

The stress analysis was conducted on the machine. It can be concluded clearly that the beams (middle position) of the body do not undergo too much stress (**Figure 4(a)**). It can be seen in the analysis that the beam is indicated in green color after the forces are loaded. Subsequently, the beam is in a proper structure and will withstand the force and pressure after the body is loaded with storage tank and hardware. Hence, it is safe to use. In addition, the top and bottom positions of the body is indicated in blue color. This means there are no force and pressure subjected on them.

The stress and strain are correlated in structural steel. The elastic modulus and stress limits are proportional while stress and strain are directly proportional (Arasaratnam *et al.*, 2011; Kareem, 2013). The strain analysis was also conducted for the structure. Strain can be defined as the condition of a certain body when force is subjected to it. Strain normally occurs in two conditions: elongation and extension. **Figure 4(b)** shows the strain analysis results. It can be concluded that the top portion is subjected to a little more strain than middle based on the chart.

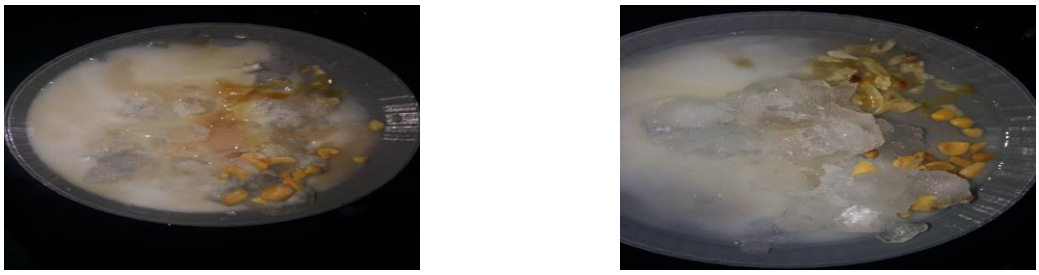
3.4. Geometrical testing

Geometrical testing is the testing conducted to compare the accuracy of the fabricated parts and the designed model in solidworks software. This testing was conducted using some selected parts. All the collected data were recorded and tabulated. This test was conducted using a 7.5-meter measuring tape. In some parts, the dimension of the actual part were not 100% matched as the designed modal in software. The range of the error was between ± 0.01 mm to ±0.05 mm. This can be occurred because of the tool size thickness in the cutting machine.



(a) Stress analysis **(b) Strain analysis**

Figure 4. Frame analysis result



(a) Auto mode product **(b) Manual mode product**

Figure 5. Final product testing

3.5. Final product testing

Figure 5(a) shows the output of the auto mode. The final product appearance met the requirements. The manual mode was also tested in the same machine. The manual mode final product is shown in **Figure 5(b)**. In this mode, the machine was set to the minimum level of syrup. As can be seen in both figure in **Figure 5**, the syrup can be clearly seen as brown color but it was less in color for the product in **Figure 5(b)** compared to the auto mode in **Figure 5(a)**. In manual mode, the final product appearance did not meet the requirements.

4. CONCLUSION

The Ais Kacang vending machine was succesfully fabricated using ranking method selection. This customized Ais Kacang vending machine dispenses the ingredients into a prepared plate. The vending machine consists of dual modes, the automatic and manual mode. Based on this project, this vending machine was designed and developed to introduce a new electrical appliance to this modern world which will help to reduce manpower in producing Ais Kacang.

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