CONCEPTUAL DESIGN OF AN IMPROVED TRADITIONAL TOFU PRINTING MACHINE

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ABSTRACT

This study highlights the design process of an improved traditional tofu printing machine. The identified traditional tofu printing machine is currently manually operated, resulting in less efficient energy consumption and quality of tofu production. Therefore, this study aims to help the traditional tofu producer convert the manual process into a semi-automatic tofu printing machine. The design process starts with the need identification, then the creation of Product Design Specification, and lastly, the generation and selection of concepts thru the aid of Morphological and Pugh methods. It was found that the chosen concept was able to press the soymilk efficiently using semi-automatic stamping components. Thus, this helps in saving the human energy usage, cost, and time if using the stamping machine.

Keywords: Tofu Printing Machine, Morphological Method, Pugh Method

1.   INTRODUCTION

Soybean is a type of crop which is available worldwide. It has phytonutrients such as phytosterols and soy isoflavones that can improve glucose tolerance and reduce the low-density cholesterol in the human body, thus improving human health [1]. One of the by-products of soybean is tofu, which is considered an excellent protein source due to its high-quality protein and digestibility [2]. There are many types of tofu available in the market to meet the different needs of consumers; each is produced via a different complex process [3]. Tofu production sometimes includes the process of soaking, grinding, cooking, clumping, printing, and frying, which is unique to the location where it has been produced [4].

In Malaysia, tofu production is usually done through manual and automatic processes. One local traditional tofu producer has made the tofu using the printing method using a mould made from wood [5], shown in Figure 1 below. The process starts with soymilk made from the soybean. Later, this soymilk is poured into the wooded mould, and a mould cover is placed on top of it. Next, a car jack is placed on the wooded cover to pressure the soymilk. Besides that, a few bricks also are placed all over the wooded cover to distribute along the wooded cover area.

Figure 1: The Traditional Tofu Printing Machine

However, this process is not very efficient and suitable for food processing activities scenarios. Besides that, a lot of human force is used to jack the cover to give the soymilk the required pressure. Therefore, there is a need to improve the tofu printing machine to help the operator with the production and increase the quality of tofu produces. Thus, this study discusses and highlights the conceptual design of the proposed machine.

2.   DESIGN FRAMEWORK OF AN IMPROVED TRADITIONAL TOFU PRINTING MACHINE

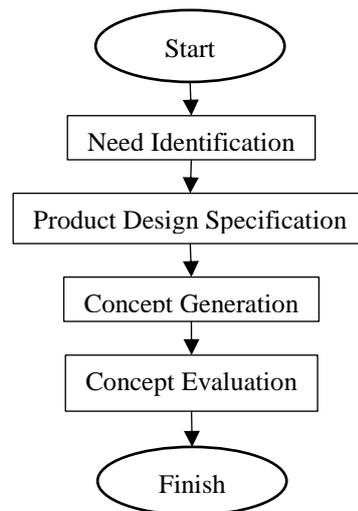The design process of this study is shown in Figure 2 below.

Figure 2: Flowchart of the design process

2.1   Need Identification

The design process started with identifying and selecting the traditional tofu printing machine type for the study case of this design project. As shown previously in Figure 1, a traditional tofu printing machine is selected as the study case for this study. This machine is traditionally used to produce and shape tofu into the desired shape. Based on the interview [5] with the tofu producer, the identified problem related to the traditional tofu printing machine is shown in Table 1 below. Hence, an improved traditional tofu printing machine to solve the problem mentioned above is developed and introduced in this paper.

Table 1: Problem-related to Tofu Printing Machine

No	Problem
1	Difficulties in controlling the process of pressing the concentrated soy milk which results in tofu becoming less compact and easily scrambled
2	The current method of pressing the concentrated soy milk by using carjack is not suitable for food processing activities
3	Few bricks are also used to put on top of the tofu printing machine to ensure all tofu receives equal compaction force, which results in the tofu maker being unable to identify whether the tofu is completely comparted or not

2.2   Product Design Specification

Table 2 shows the Product Design Specification (PDS) of an improved traditional tofu printing machine. PDS is a document that states and defines how a product is made and contains information related to product development outcomes. A total of 9 parameters are set in the PDS.

3.0   RESULT AND DISCUSSION

3.1   Concept Generation

The morphological matrix, as shown in Table 3, is used to generate concepts analytically and systematically. There are eight (8) sub-function, and each sub-function has at least two (2) option solutions. Later, three (3) concepts are made through the possible combinations of option solutions for each sub-function.

Table 2: Product Design Specification of an Improved Traditional Tofu Printing Machine

| Parameter	Description
Performance	Able to press of load less than 12kg for the concentrated soy milk inside the tofu machine maker
	Able to give an output of square shape of concentrated soy milk
	Able to accommodate 3kg of soymilk and 7 litres of water
Economy	Cost of a product no more than RM700 due to market price range
Customer	This product focus on the experience of a tofu maker
Environment	This product is subjected to indoor usage
Size	Overall size, L x w x h = 52 cm x 52 cm x 6cm
	Tofu mould, L x w x h = 6 cm x 6 cm x3 cm
	Able to produce 64 pieces of tofu per session
Weight	Less than 40 kg
Material	The body of the tofu printing is made of durable wood.
	Mould and the presser are made of aluminium, which is good in lightweight, durable, and recyclable.
Ergonomics	Product easy to handle, operate, adjust, and maintain.
	A product that is not too high and too low. It is comfortable for a user to process the tofu.
Safety	Have all relevant safety features

The combinations of option-solution for the final three (3) concepts are shown in Table 4. For the first concept, the tofu is pressed using a hydraulic machine and later cut into shape manually by a knife. For the second and third concepts, the concentrated soymilk is placed in the printing base that holds the mould cover. Later, the soymilk is pressed to produce tofu and finally cut using the stamping

cutter. The only difference between concepts 2 and 3 is that the first uses manual pressing, and the later uses the auto press machine.

Table 3: Morphological Matrix for Improve Traditional Tofu Printing Machine

Sub-function	Option-solution
Printing Base	A1 Manual box tofu with process fit box A2 Roller bottom/based A3 Basic square bottom base
Power Source	B1 2 pin plug B2 3 pin plug B3 USB B4 Battery
Mould/Shape	C1 No Shape C2 Square C3 Circle C4 Triangle
Presser	D1 Manual pressing machine D2 Auto stamping machine D3 Hydraulic pressing machine D4 Pneumatic pressing machine
Mechanism	E1 Motor E2 Generator
Rotatory	F1 Pulley F2 Gear F3 Hand
Cutter	H1 Round/straight cutter H2 Manual cutter H3 Stamping cutter H4 Knife
Table support	I1 Straight beam I2 Cross beam I3 Truss beam

Table 4: Generation of Concept for An Improvement of Traditional Tofu Printing Machine

Concept	1	2	3
Selected Option-Solution	A3 + B2 + C1 + D3 + E2 + F3 + H2 + I1	A2 + C2 + D1 + E2 + F2 + H3	A2 + B2 + C2 + D2 + E1 + H3 + I3
Figure			
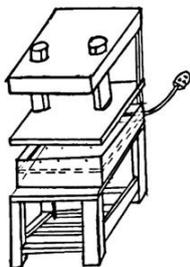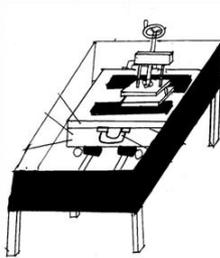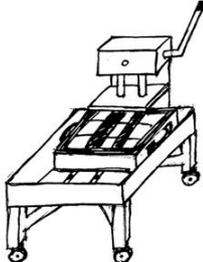
3.2　　Concept Selection

Later, these three concepts are evaluated to determine the final concept to be used as the product design by using the Pugh method. The selection Pugh method is shown in Table 5 below.

Table 5: Pugh Matrix of an Improved Traditional Tofu Printing Machine

Assessment criteria	Weightage	Concept		
		1	2	3
Pressing soymilk	3	++	0	++
Stability	3	+	0	+
Portable	1	-	-	+
Safety	3	0	+	+
Usable	1	+	0	-
Energy	2	+	0	+
Time	2	++	0	++
Aesthetic	1	+	-	-
Cutter size	2	0	+	+
Blade design	1	0	++	+
Extra equipment	1	+	+	+
Cost	3	--	--	-
Total		**13**	**5**	**23**

Based on the Pugh matrix of Table 5 above, the total point of each concept for Concepts 1, 2, and 3 are 13, 5, and 23. Thus, the chosen concept is Concept 3, with the highest marks. This concept can press the soymilk efficiently in terms of energy usage, cost and time by using the stamping machine and the wall plug. It also has the stability and portability of a machine body with a roller for moving purposes. In terms of safety, it uses a stamping cutter which protects the operator from cutting the tofu manually.

4.　　CONCLUSION

This study has shown that concept 3 is the best concept for the improvement of traditional tofu printing machine for the tofu producer for which; the concept helps the traditional tofu printer in terms of time, energy, safety, and tofu quality by converting the manual process into a semi-automatic process of pressing the soymilk to become tofu.

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