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Design and Development of a Semi-automated Machine in Producing Multi-Biscuit for Small Industries

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Abstract: This project was carried out to develop a prototype semi-automated multi-biscuit machine kuih semperit and biscuit badam, bangkit and mama carey maker using roller stamp mechanism for small and medium entrepreneurs (SMEs). The main function of this machine is to produce a high rate of production of kuih semperit and biscuit badam, bangkit and mama carey. This machine consists of several key components which are motor, conveyors, two different types of rollers, and cutter. The roller and the conveyor are driven by two different motors [1]. This integrates the previous machine to increase production rate, reduce the processing time and save human power usage. Descriptions are shown in this report. In this project, a series of analyses are carried out, the analysis was production cost analysis, production rate analysis, and breakeven analysis. Based on production rate analysis, the product can be increased to 45 000 to 46 000 pieces per month and net profit was RM4 900 to RM5 400 per month.

Keywords: Multi-biscuit, Semi-Automated Machine, Small Industries

1. Introduction

Traditional biscuit among the Malaysian society is most popular especially when celebration day such as 'Hari Raya Puasa', Chinese New Year, Christmas, Deepavali or as snack items whether at parties or gathering of family [2]. However, we do not expect that these small and medium industries which play an important role in generating income for the economic in Malaysia. Actually, traditional biscuit comes from old generation menu and young generation which makes small modification by adding the menus to be more delicious in attracting biscuit fans [7]. The rural or small food industries is one of the businesses that we predict to gain attention in the local market which they can expand their business into the overseas market. It also makes good economy among the rural people to improve their daily life [8]. Nevertheless, the products are produced by the rural food industry, and they are still use traditional technique inherited from their ancestor. In that case, the government was taking various steps to help the small entrepreneur enhance their income in the development of the manufacturer food technology sector of small and medium industries [3]. Therefore, in this project research has been done

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to produce kuih semperit, biscuit badam, bangkit and mama carey biscuits. There are several problems faced by the kuih and biscuit entrepreneurs, which is they often do not have enough time to meet customer demand. The amount of product production conventionally or manually is also limited. This is because the process of making kuih semperit, biscuit badam, bangkit and mama carey is a bit complicated and slow, causing entrepreneurs to not be able to produce products in large quantities at one time, indirectly requires a lot of manpower to make these products. As we all know, most of the machines on the market are quite limited in making a kuih or biscuit. Furthermore, the machines for the produce of kuih and biscuits are done separately, and every machine requires a high cost to purchase [4].

1.1 Problem statement

Biscuit making in small and medium industries was still using the manual or traditional method for producing any kind of biscuit-like bangkit, mama carey, badam, semperit, and so on. The semi-auto machine should be introduced in this industry. Based on observations made, the biscuit industry still using a manual method to produce it. Manual method is only capable of producing small quantities of biscuits and takes a long time to produce. Undeniably, this type of food business has created a high demand among consumers. Therefore, a semi-automated multi-biscuit machine should be introduced. The need for machine which is affordable in price is vital to help them increasing their production rate.

The machine in the market just focuses on one biscuit. Currently most of the available machineries in the market can only produce one type of biscuit, such as machine rolling the dough while most of patterning process such as samperit or bangkit are carried out hand made. Therefore, to save time a semi-automatic machine that combines roller dough, semperit pattern, and any kind of biscuit pattern should be introduced.

Presently in the non-productive traditional method of production, and innovation on simple machinery is highly needed within this industry in order to ensure that this industry will grow rapidly to meet the demand. Also, the problem is when the high demand of the consumer influences the increase in the price of the product. Thus, simple machinery is much needed to cater to this problem. Within this study, an affordable price of machinery at around rm5000 to rm7000 is targeted.

1.2 Objectives

With the creation of this machine, it is hoped to help SME entrepreneurs in further increasing the production rate of products. This machine can produce mainly two types of biscuits using only one type of machine. Entrepreneurs do not have to buy many machines to produce different types of biscuits. It is also expected to be able to produce up 2 to 3 times as much. The machine is also easy to use and only requires one worker to operate it. It is expected to some extent which can save time and reduces manpower.

2. Materials and Methods

The materials and methods section, otherwise known as methodology, describes all the necessary information that is required to obtain the results of the study.

2.1 Materials

Aluminum is the primary material utilized in the development of this project. Aluminum is suitable over other materials because of its great corrosion resistance, high strength, and ease of machining [5]. Furthermore, aluminum is a material that is suggested for food-related machinery.

Table 1: List of material

Name	Picture	Component Involved	Selection Factor
Aluminum 5083		Slider	• Non-corrosive
Stainless Steel AISI 316		Conveyor pulley	• High tensile strength • Good formability
Carbon Steel		Frame	• High strength • High ductility Excellent for machining, welding • Low cost.
Plastic		Roller	• High mechanical strength • Low water absorption • safely used on food

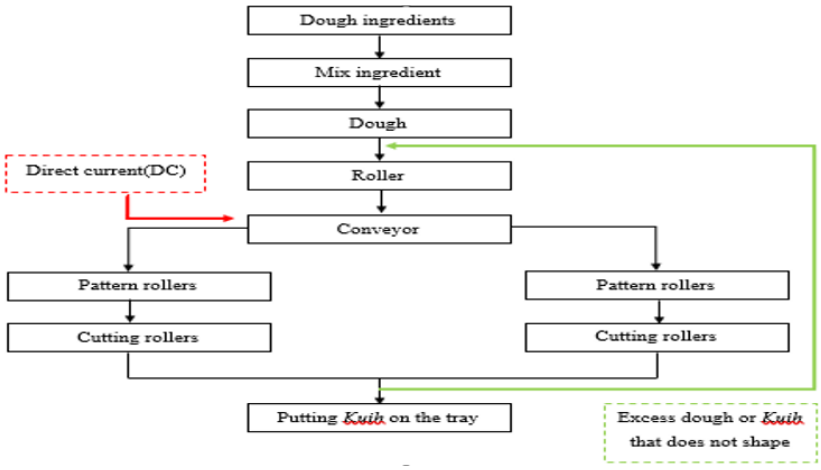

Figure 1: Schematic diagram of product

2.2 Equipment

The devices used for this case study were Electric Scooter DC motor 24V 350W and DC Motor Speed Controller.

Figure 2: Electric Scooter DC motor 24V 350W

Figure 3: DC Motor Speed Controller

2.3 Conceptual Design

At this phase, alternative design concepts are evaluated and selected. In addition, this phase describes a system overview of a system of ideas and concepts of what needs to be done [6]. This method also simplifies the process of making the machine by using the right components and more specific.

Table 2: Concept selection

No.	Function	Specification
1	Funnel	Aluminum
2	Structure	Steel
3	Conveyor belt	Fabric
4	Roller stand	Aluminum
5	Power source	Electric
6	Switch ON/OFF	Push button
7	Shaping tool	Aluminum
8	Conveyor pulley	Stainless steel
9	Cutting tool	Zinc

2.4 Deign selection

After going through all the required steps, the final design was selected after taking into consideration a number of factors. Functionality, safety, selection of materials, and size are all aspects to consider while developing a design.

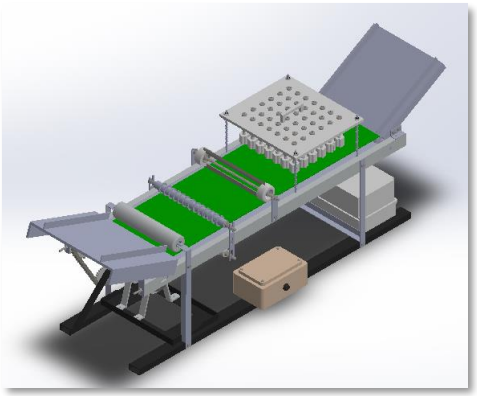

Figure 4: Final Assembly Drawing Machine

This project participates in helping Small and Medium Enterprises (SMEs) to increase product productivity and compete with others in food marketing. The operator will take advantage of the rolling, rolling shape of *semperit* and produced a pattern of biscuit at the specified time. Reasonable machine price is worth to be bought by SME entrepreneurs where it will give more profit to the entrepreneurs.

2.3 Equations

This Equation and formula are used to determine the Standard time and Normal time, which are the times when work should be completed without delay. While the Standard time is the time it takes the worker to accomplish the task with some inevitable delays.

$$Normal\ time = Average\ time\ \times Rating \qquad Eq.1$$

And

$$Standard\ time = Normal\ time\ \times \frac{1}{1-allowance} \qquad \text{Eq. 2}$$

$$Production\ rate = \frac{working\ time\ for\ an\ employee}{Total\ standard\ time} \qquad Eq.3$$

Total costs and profits will be calculated below:

$$Total\ cost = raw\ material + labour\ cost \qquad Eq.4$$

and

$$Profit = total\ sales\ revenue - total\ cost \qquad Eq.5$$

The break-even analysis determines how many units of a product must be sold in order to pay the fixed and variable costs of manufacturing. The break-even point is used to calculate the margin of safety. Break-even analysis is widely utilized in a variety of contexts, ranging from stock and option trading to corporate budgeting for various initiatives.

$$Breaeven\ sales\ unit = x = \frac{FC}{P - V} \qquad Eq.6$$

3. Results and Discussion

In this part describes in detail the process of making this semi-automated multi-biscuit machine. Each component has its own manufacturing process and is meticulously done. In addition, in the machine manufacturing process, several factors need to be emphasized so that no problems will occur during the manufacturing process, specifically safety factors are the part that we are focus on. Safety must be maintained so that no injuries occur and produce the product safely. Several processes have been done to develop this semi-automated multi-biscuit machine.

Figure 5: Final Product After Fabricate

The results and discussion section presents data and analysis of the study. This section can be organized based on the stated objectives, the chronological timeline, different case groupings, different experimental configurations, or any logical order as deemed appropriate.

3.1 Production rate analysis

3.1.1 *Kuih Semperit*

The machine has been tested several times to test the performance and efficiency. Dough of biscuits were used as the subject of the test. The machine has been through several testing sessions. The testing is made based on the ability of the machine to fully function when the producing in *kuih* is in progress. The aspect including speed during the dough is rolled, the dough is cut, selection of *kuih* before arrangement and efficiency of the machine has been considered during the testing session.

Table 3: Results of testing *Kuih Semperit*

Cycle / Test (min)	Cycle 1 (Dough is rolled)	Cycle 2 (Dough is cut)	Cycle 3 (Kuih selection and arrangement)	Average time
Test 1 `	0.52	0.42	0.61	0.52
Test 2	0.54	0.48	0.58	0.53
Test 3	0.51	0.45	0.62	0.53

Table 4: Results of Normal Time and Standard Time

Cycle / Test (min)	Average time (min)	Normal time (min)	Standard time (min)
Test 1 `	0.52	0.52	0.58
Test 2	0.54	0.54	0.61
Test 3	0.51	0.51	0.57

The production rate of *kuih semperit* using a semi-auto machine is twice as much as using a manual machine. Meanwhile, three times more production rate compared to traditional methods.

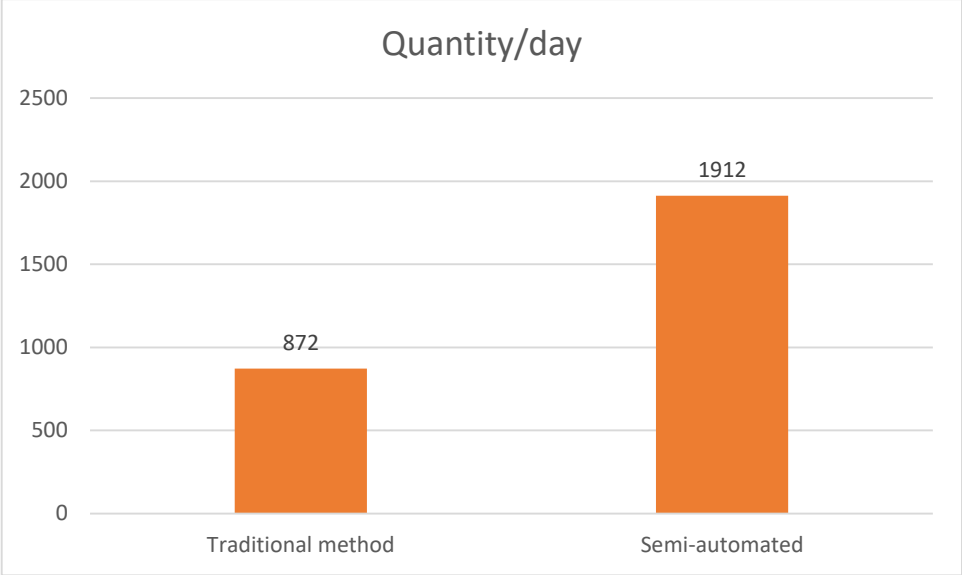

Figure 6: Production Rate of *Kuih Semperit*

3.1.2 Biscuit Badam

In this experiment, there were three cycles for making biscuit *badam, bangkit and mama carey*. The first cycle is that the dough is formed into small pieces for easy insertion into the rolling machine. The second cycle is that after the dough is rolled, it will go down to the conveyor. Then the dough is formed and cut. Lastly, the third cycle is the selection of quality biscuits and the arrangement of biscuits on trays before the biscuits are baked. Each process performed will be repeated three times.

Table 5: Results of Testing Biscuits

Cycle / Test (min)	Cycle 1 (Dough is rolled)	Cycle 2 (Dough is cut)	Cycle 3 (Kuih selection and arrangement)	Average time (min)
Test 1 `	0.53	0.44	0.71	0.56
Test 2	0.55	0.47	0.70	0.57
Test 3	0.59	0.45	0.74	0.59

Table 6: Results Normal Time and Standard Time

Cycle / Test (min)	Average time (min)	Normal time (min)	Standard time (min)
Test 1 `	0.56	0.56	0.63
Test 2	0.57	0.57	0.64
Test 3	0.59	0.59	0.66

The production rate of biscuits *badam* using a semi-automated machine is twice as much as using the manual method, which is the traditional method.

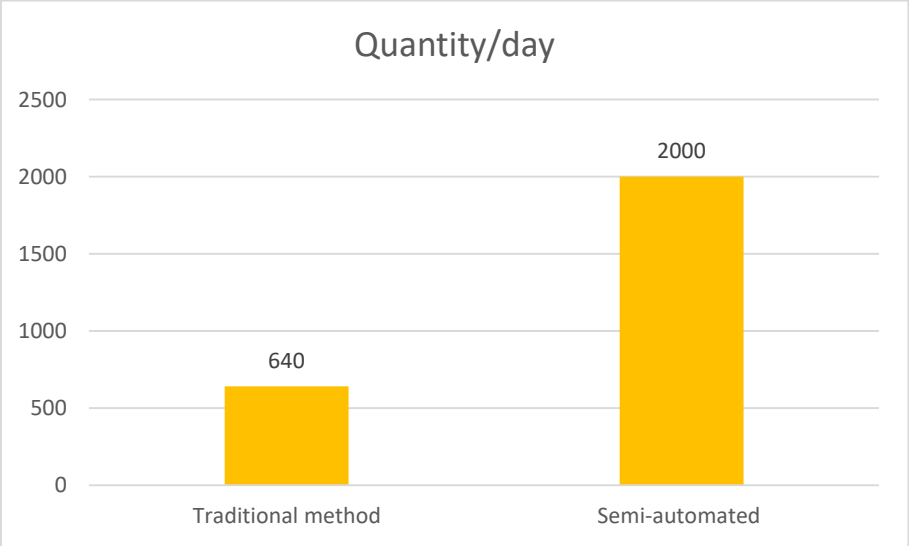

Figure 7: Production Rate of Biscuits

3.2 Discussions

3.2.1 Breakeven point

The break-even point for the sale of this machine is RM16 666.80, which can sell 41 667 pieces of *kuih semperit*. After the break -even point, the sales proceeds will be net profit. The figure shows a break -even graph of sales revenue.

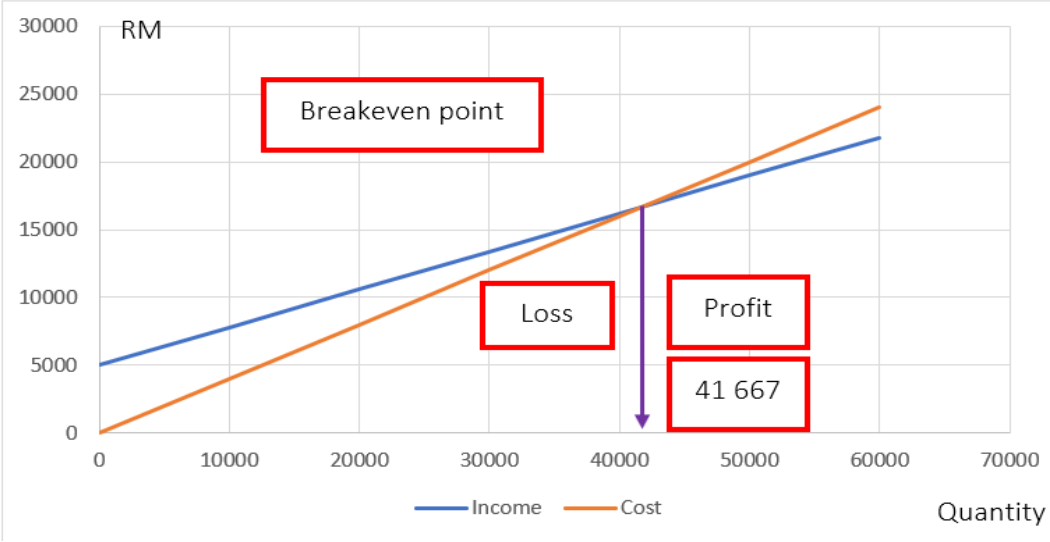

Figure 8: Graph of Breakeven point

The semi-automated multi-biscuit machine can produce 1912 pieces/day. To achieve the number of biscuits that need to be sold to get breakeven which is 41 667 pieces, entrepreneurs need to sell 1912 pieces every day for 22 days to achieve breakeven.

4. Conclusion

The results of the study that has been conducted on these various biscuits machines have achieved the objectives of this study. When using this machine, the production rate can be increased, can reduce the biscuits processing time, and reduce manpower. Studies from this project can also change the method of producing biscuits from a manual method to a semi-automated machine. A new concept has also been integrated into this machine, which produces a positive effect, especially on energy consumption, time, and production rate. Moreover, from this study there are some problems that exist when the machine is tested, and all the problems can be avoided and solved.

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