DEVELOPMENT OF ROLL PINEAPPLE TART MACHINE

Submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering (Hons.)

by

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfillment of the requirements for Degree of Manufacturing Engineering (Hons.). The member of supervisory committee is as follows:

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ABSTRAK

Dalam pembuatan berskala besar tart nenas gulung, prosess pembuatannya memerlukan mesin. Namun, hanya mesin manual dan semi-automatik yang terdapat dipasaran. Mesin yang digunakan juga hanya untuk mengeluarkan doh dan proses lain perlu dijalankan oleh operator dan dibuat secara manual. Tujuan utama projek ini adalah untuk membangunkan dan membuat mesin tart nenas gulung untuk meningkatkan kecekapan pengeluaran dan menyelesaikan masalah lain yang timbul kerana masih belum ada mesin tat nenas gulung yang automatik di pasaran. Dalam projek ini, mesin tart nenas gulung yang automatik akan dibangunkan untuk meningkatkan kadar pengeluaran dan reka bentuk dengan kapasiti yang sesuai dengan industri makanan kecil dan sederhana. Mesin yang dibangunkan menggunakan dua piston ram extruder untuk mengeluarkan doh tart dan jem nenas, penghantar digunakan untuk menyambungkan semua bahagian mesin termasuk bahagian penggulung untuk menghasilkan tart nanas gulung yang lengkap pada akhir proses. Mesin ini akan menghasilkan 100 biji tart nenas gulung pada akhir satu kitaran mesin yang sedang berjalan. Hal ini kerana permintaan pelanggan yang telah dikenal pasti dari soal selidik yang telah diedarkan kepada penjual tart nenas gulung. Proses rekabentuk mesin ini menggunakan prosess rekabentuk mekanikal yang melibatkan Aplikasi Pembahagian Fungsi Kualiti dan Rumah Kualiti. Prosess rekabentuk ini digunakan untuk memilih rekabentuk yang terbaik untuk menghasilkan rekabentuk konsep. Kemudian, pembinaan mesin ini juga melibatkan aktiviti pembelian komponen, fabrikasi mekanikal, pemasangan elektro-pneumatik, pengujian, baikpulih mesin dan memprogram Pengawal Logik boleh atur cara. Selepas mesin diuji, masa yang diambil untuk mengahsilkan tart meningkat sebanyak 59.59% berbanding dengan membuat secara manual. Penambahbaikan boleh dilakukan pada mesin untuk mengasilkan bentuk tat yang lebih baik dan memendekkan lagi masa pembuatannya.

ABSTRACT

In mass production of roll pineapple tart, a machine is required in the production line. Current roll pineapple tart machine is not automated. The machine only used to extrude the dough and the other process are being conducted by an operator and manually handled. The main purpose of this project is to develop and fabricate a roll pineapple tarts machine in order to increase the efficiency of production and solve other problems arise since there is still no automated roll pineapple tart machine in the market. In this project, an automated Roll Pineapple Tart machine will be developed to increase the production rate and designed with the capacity that is suitable for the small-scale food industry. The developed machine is using two piston ram extruder to extrude tart dough and pineapple jam, a conveyor is used to connect all the part of the machine including the roller part to produce a complete roll pineapple tart at the end of the process. The machine will produce 100 pieces of roll pineapple tart at the end of one cycle of the running machine. This is due to the customer demand identified from the questionnaire that has been distributed to bakeries that sell roll pineapple tart. The design process of the machine is using the Mechanical Design Process which involving Quality Functional Deployment and House of Quality. The design process is used to select the best design in order to generate conceptual design. Then, the development of the machine involves the activities of components purchasing, mechanical fabrication, electro-pneumatic installation, testing, machine repairing, and Programmable Logic Controller programming. After the testing, the results of the time taken for the developed machine was increased to 59.59% as o be compared to the manually handled roll pineapple tart making process. Some improvement can be done in order to produce a better shape of the tart and shorten the time taken for the production.

DEDICATION

Specially dedicated to my beloved parents, Alias Bin Othman and Norilah Binti Zainol and family for the support, beliefs, and motivation.

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LIST OF ABBREVIATIONS

SME	-	Small and Medium Enterprise
PLC	-	Programmable Logic Controller
PSM	-	Projek Sarjana Muda
FKP	-	Fakulti Kejuruteraan Pembuatan
UTeM	-	Universiti Teknikal Malaysia Melaka
QFD	-	Quality functional Deployment
GDP	-	Gross Domestic Product
PTFE	-	Polytetrafluoroethylene
PVC	-	Polyvinyl Chloride
PE	-	Polyethylene
PS	-	Polystyrene
PC	-	Polycarbonate
PUR	-	Polyurethane
MF	-	Melamine-formaldehyde.
PVDF	-	Polyvinylidene fluoride
BOM	-	Bill of Material
CNC	-	Computer Numerical Control

LIST OF SYMBOLS

cm	-	Centimeter
in	-	Inch
° C	-	Degree Celsius
π	-	Pi
lb	-	Pound
psi	-	Per Square Inch
H_2S	-	Hydrogen Sulfide
mg	-	Milligram
L	-	Liter
ppm	-	Parts Per Million
MPa	-	Mega Pascal
mm	-	Millimeter
m/s	-	Meter Per Second
gm	-	Gram
s	-	Second
min	-	Minute

CHAPTER 1
INTRODUCTION

A brief introduction regarding this project is presented in this chapter. The first topic is about the background in the development of roll pineapple tart machine. Then, the detail of the problem statement of the project will be described. Next, it will be followed by the objectives of the project. Based on the problem statement and also the objectives of the project, the scope of this project is known. Finally, the report structure of this project will be presented.

1.1 Project Background

Pineapple tart is a buttery pastry stuffed with pineapple jam. It is a very popular "festive cookies", especially in Singapore and Malaysia. According to Foo (2017), the filling is made from fresh pineapple mixed with sugar and cinnamon, cooked and reduced until caramelized. Pineapple tarts are popular in Malaysia, Indonesia, Singapore, and Taiwan especially during the festival such as the Chinese New Year. Ho (2018) stated that in Taiwan, the pineapple cookies are in a rectangular shape. They love to have pineapple tarts during Chinese New Year because it signifies success and prosperity thus, it is a must-serve treat. This cookie is a bite-sized tart stuffed with, rolled with or topped with pineapple jam and they are common in South East Asia. The dough for creating pineapple tarts consists of a high quantity of butter, which supply it a buttery, rich, tender and melt-in-the-mouth texture (Siahaja, 2009).

Cookies seem to be leading the food industry because of its taste, flavors, shape, innovative packaging, new technologies and rising health consciousness among consumers (Smith, 2019). For mass-production of cookies, the manually-handled technique seems to be

unpractical due to some factors. Thus, a fully automated machine is needed for the large and medium scale business industries.

The machine uses the concept that relates to cookie machinery and more particularly to automatic machines for depositing the dough. It uses the concept of extrusion which the dies are made according to the desired shape of the tart pastry. The extrusion concept is also used to produce the shape of the pineapple jam. The rolling concept is being adopted by the conveyor system and the linear motion of the barrier.

1.2 Problem Statement

Roll Pineapple tart has become popular as baked pastries among Malaysian and Singaporean. Not only focused on the Chinese race, but it also been familiarizing for other races such as Malay and Indian in Malaysia. However, for mass-production of these cookies, there is still no automated Roll pineapple Tart in the market. When only semi-auto and manual machines exist in the market, some issue might occur. One of them is the productivity of cookies is low. Then, there is a hygienic factor since there is a lot of hand-operated process of production to reduce the period of manufacturing. Next, the uniformity of the cookies may vary depending on the technique used by each operator. Therefore it is proposed that a fully automated roll pineapple tart machine be developed.

1.3 Objective

To ensure the machine developed meets the requirement needed, objectives of the project must be set. This is to prevent nonvalue-added parts or components of the machine. The first objective is to develop an automated roll pineapple tart machine. Other than that, the objective is to ensure the machine produced will increase the productivity rate compared to the manually handed process.

1.4 Scope

The machine developed will be targeted the small industry as Small and Medium Enterprise (SME) since the machine production rate will be set as 100 pieces per cycle. The rate of production for 100 pieces per cycle is the results obtain from the questionnaire distributed. Most of the respondents agree with the rate of production for this machine to be set as 100 pieces. This is because 100 pieces are the most suitable value of production for SME. The questionnaire question will be attached in Appendix A. The time taken for the machine to complete each cycle will be set as around 40 minutes. The materials and components used to develop the machine will be limited to the available material and components from the laboratory of Fakulti Kejuruteraan Pembuatan (FKP) Universiti Teknikal Malaysia Melaka (UTeM). Other than that, the fabrication and manufacturing process of the machine will only be using the facilities, equipment, and tool from the FKP UTeM Laboratory.

1.5 Report Structure

In this report, Chapter 1 is the introduction. In Chapter 2, it consists of a literature review on Roll Pineapple Tart. This chapter gives types of pineapple tart, explains the concept used in the machine, elaborates application of programmable logic controller, and explains the pneumatic system, motor system and linear motion in the machine. Next, the methodology will be discussed in Chapter 3. This chapter discusses the general flowchart for this project methodology, Quality Functional Deployment (QFD), conceptual design and product development. Chapter 4 is about results and discussion involving the development of the machine, machine testing, the roll pineapple tart produced and productivity. Finally, in Chapter 4 the conclusion is given and recommendation for future research. At the same time, it gives sustainability of the product, lifelong learning and the complexity element in the project.

CHAPTER 2
LITERATURE REVIEW

In this chapter, there are 8 main topics will be discussed. The first topic is SME that will show the importance of SME in Malaysia economy. Next topic is pineapple tart industry, which explains the development of pineapple tart. After that, the topic of the type of pineapple tarts is discussed. In the topic of roll pineapple tart making technique, the steps and method used to make the cookies are being discussed. As in dough extrusion topic, the types of the extruder used for extrusion are discussed. In pneumatic extrusion topic, a few formulae are given to do the calculation in order to choose the best pneumatic cylinder in an application. Lastly, in the food industry requirements topic, the guideline in choosing materials for constructing food machinery are discussed.

2.1 SME

There was certainly not been an agreement of the criteria should be used in order to give a definition of small and medium enterprise. However, the most definition seems to have been ruled by the concern of perceiver, the purpose to be obliged and acted of growth for specific country and economic background in which the meaning of SME is to be used. An overall tendency between the empirical researches is, to express SMEs by the definite size of enterprises which are measured by the number of the employee or the cost of capital or fixed assets or a combination of both (Abdullah, 1999). It is categorized as a small enterprise by having a capital cost of below RM 500,000 while categorizing as a medium enterprise by having a capital cost below RM 2.5 million ("Annual Report 1990/91," 1990). However, the national SME Development Council redefined SMEs as those with an annual sales turnover of below RM 25

million and having below 150 full-time employees ("Small & Medium Enterprises in Malaysia: potential and prospects," 2010). In three study conducted in Malaysia by three international agencies, i.e. World Bank ("Malaysia: Development issues and prospects of small enterprises," 1984), United Nation Development Organization (UNIDO, 1986) and Asian Development Bank ("Asian Development Bank," 1990). They define small-scale enterprises as the company hiring less than 50 workers, medium-scale enterprises as the company hiring between 50 and 199 workers and large-scale enterprises as the company hiring more than 200 employees.

Chee (1979) defines small and medium enterprises as the company that hires less than 50 and less than 200 full-time employees respectively. Other than that, Aziz (1981) stated that small and medium enterprise as a company that hires less than 200 employees. On the other hand, Claphm (1982) categorizes small and medium enterprises in Malaysia as the company that hiring between 10 and 100 full-time workers.

SMEs plays an important role in the Malaysian Economy. Even though SMEs might not have equal the incomes and abilities of bigger businesses, SMEs are still recognized as to offer employment, present innovations, inspire rivalry, support large businesses and produce merchandises and services with higher efficiency and more effectively compared to larger businesses in some cases (Hashim, 2007).

It is generally acknowledged in Malaysia and elsewhere that SMEs have a substantial contribution to make the national economy. According to the SME Malaysia annual report for 2006, SMEs contributed 32% of real Gross Domestic Product (GDP), and 19% of exports even though they are accounted for 99.2% of all companies' formations,

Research shows that contribution of SMEs can be sawed by the amount of dearth improvement, preparation platform for developing and advancement entrepreneurship skills, significant transportation for upholding onward and backward connections in geographically and economically of various sectors of the economy in many countries (Abdullah, 1999).

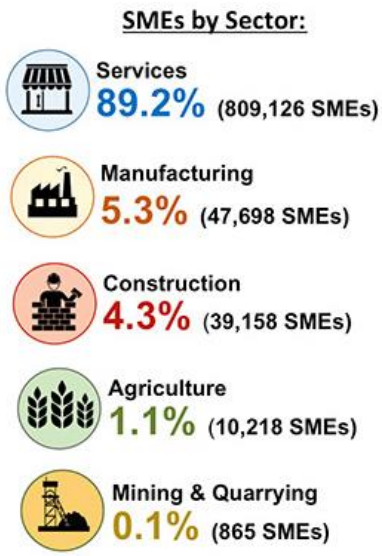

Figure 2.1: Sector in SME (SME Statistics, 2018)

Figure 2.1 shows the sectors in SME which consist of services, manufacturing, construction, agriculture and mining and quarrying. The percentage of the services sector is the highest which is 89.2 % in 2016. In the services sector, there are food and beverages, accommodation and wholesale and retail trade. From these statistics, it is proven that the food and beverages industry is one of the main business in Malaysia and the backbone in the economy.

2.2 The Origin of Pineapple Tart Industry

Due to the demand, the industry of pineapple tart has been developed. In Taiwan, these sweet cookies have been developed to be so popular that is claimed as the same breath as stinky tofu among experts of Taiwanese snacks. The tart is also known as pineapple rolls, nastar, pineapple cookies, and pineapple shortcakes Dissimilar to the putrid bean curd, pineapple tart can be easily wrapped and gifted. The rising of pineapple tart's popularity makes the existence of Taiwan as a popular location for Asian tourists for this previous seven years. According to the observers, the biggest buyers of pineapple tarts are from mainland Chinese that traveling in a tour group. The cookies are also synonym with free Chinese tourists, including Hong Kongers,

Japanese, South Koreans, and Singaporeans. Entire income for Taiwan's pineapple tart bakeries has climbed from the NT$3 billion (US$91.6 million) recorded in 2006 to NT$40 billion (US$1.2 billion) in 2013, according to comments that then Taipei City Mayor Hau Lung-pin made at the 2014 Taipei Pineapple Cake Festival (Fulco, 2016).

Sunny Hill, Chia-Te Bakery Co and Manna Foods are some of the popular company in Taiwan that doing the business of pineapple tart. As the increase of request for pineapple tarts in these current years, the sellers of the product also increases in the market. Therefore, to be the bestseller in the market, the way should be done is by concentrating on the best market section. They accept online demand and also provides domain shops on a full basis. To ensure the quality of the pineapple tart, they avoid using chemical or preservatives and use organic pineapple. Some of the best suppliers are from Aboriginal planters in the highlands of Hualien, Taitung, and Pingtung. As for Manna Foods versions of Pineapple tarts, the sweetness is reduced by using malt sugar as a substitute of granulated sugar, and it ignores the milk and butter that normally included in the tart dough. Like SunnyHills, they are present a tart filled with 100% pure pineapple jam. By using the best quality of ingredients, the pineapple tarts produced will ensure the taste as to create banding of the company.

The company of Pineapple cakes will be using automated production when the demand is higher so that they will produce the pineapple tarts as the demand. The business also helps to develop local farmers business of agriculture.

To ensure the company gets the attention of most buyers, they focus on branding, which this culture has so far still not enter the typical of Taiwan's business culture. SunnyHills which the best company in producing Pineapple tarts in Taiwan will be revenue if there are other companies that can beat their branding and having the potential to damage SunnyHills name. SunnyHills is the company that aspires to demonstrate to the world that Taiwan can produce the best product. (Fulco, 2016).

2.3 Type of Pineapple Tart

The tart is defined as an open tart case with fillings. (The Oxford Pocket Dictionary of Current English, 2009). Pineapple tart is also known as pineapple rolls, nastar, pineapple cookies, and pineapple shortcakes. Since this cookie is well known in Taiwan, Malaysia, Indonesia, and Singapore, there are various recipes, shape, and name for the cookies.

There are many types of pineapple tarts, not only in the form of the quality of the tart but also the filling, whether it is enfolded within or open (Teo, 2016). The easiest way to differentiate each type of pineapple tarts is by looking at the shape. Usual shapes consist of a flat, open tart topped with pineapple jam under a lattice of pastry, rolls filled with jam that is open at the ends, and jam-filled spheres or elongated shape.

2.3.1 Open-faced Tart

The open-faced tart is also known as Nyonya pineapple tart or Peranakan pineapple tart or kuih tair. Figure 2.2 shows the Open-faced pineapple tart that has the pastry below and the jam is placed on top of the pastry. The jam is not being covered fully by the pastry.

Figure 2.2: Open-faced Tart ("Kueh Tair – Making Peranakan Pineapple Tarts," 2016)