QUALITY IMPROVEMENT ANALYSIS BY USING TAGUCHI METHOD IN SMALL MEDIUM ENTERPRISE (SME) COMPANY

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QUALITY IMPROVEMENT ANALYSIS BY USING TAGUCHI METHOD IN SMALL MEDIUM ENTERPRISE (SME) COMPANY

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Management)

by

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Management) with Honours. The members of the supervisory committee are as follow:

……..…....…

MR. HASOLOAN HAERY IAN PIETER

Supervisor of PSM

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ABSTRAK

Tujuan kajian ini ialah untuk mengoptimumkan proses pembuatan satu produk roti berdasarkan kaedah Taguchi. Taguchi ialah teknik penyelesaian masalah yang berkuasa meningkatkan proses prestasi, hasil dan produktiviti. Ia akan berguna mengurangkan kos ubahsuai dan kos perkilangan disebabkan kebolehubahan berlebihan dalam proses-proses dan ialah satu pendekatan yang berpengaruh untuk mengoptimuman proses dengan mudah, berkesan, ekonomi dan dengan bermanfaat. Kajian ini adalah bagi mengenal pasti masalah kualiti dan menentukan hubungan antara terkawal faktor-faktor reka bentuk yang terkawal (mencampurkan jenis, membakar tempoh dan membakar suhu) dan hasil-hasil proses (kualiti roti menghasilkan), selain membangunkan pembolehubah-pembolehubah terkawal yang optimum bagi meningkatkan kualiti sebagai tujuan kajian ini. Kajian ini dimulakan dengan lawatan perindustrian yang mana ialah untuk memerhati dan memahami aliran membuat proses makanan. Pemungutan data parameter terkawal seperti mencampurkan jenis, suhu-suhu mesin dan tempoh-tempoh masa mengutip merujuk kepada Orthogonal Array (OA) L_9 3^3 sebagai pilihan pemilihan komposisi parameter. Eksperimen bercorak menggunakan komposisi sembilan uji kaji cubaan pada tiga parameter bercorak. Data yang sesuai dikutip dan secara statistik melalui analisis respons-respons min serta Signal-to Noise Ratio (S / N), mengakibatkan kepada keazaman setan optimum parameter reka bentuk yang kritis. Keputusan yang diperolehi menunjukkan parameter persekitaran optimum bagi faktor-faktor adalah dicadangkan pada $A_1B_2C_2$. Secara tambahan, ia juga mendapati bahawa tempoh pembakaran itu sebagai faktor penting yang menjejaskan kualiti biasa dalam projek ini. Justifikasi eksperimen ialah memperlihatkan parameter persekitaran optimum meningkatkan kuantiti boleh diterima roti. Pada akhir kajian ini, beberapa cadangan dan cadangan diutarakan untuk meningkatkan kualiti produk bagi XXX Enterprise.

ABSTRACT

The purpose of this study is to optimize the manufacturing process of a bread product based on Taguchi's method. The Taguchi's method is a powerful problem solving technique to improve process of performance, yield and productivity. It will useful to reduce rework costs and manufacturing cost due to excessive variability in processes and is a powerful approach to address process optimization problems with simple, effective, economical and beneficial way. This study is to identify the quality problem and to determine the relationship between controllable products design factors (mixing type, baking duration and baking temperature) and the outcomes of the process (quality of the bread produced), besides to develop the optimal controllable variables to improve the quality as a goal of this study. This study is starting with industrial visit which is to observe and understand the flow of manufacturing food process. The data collections of the controlled parameters such as mixing type, machine temperatures and time durations are collected refers to Orthogonal Array (OA) of L_9 3^3 as the choice of parameter composition selection. The designed experiment utilized a nine-trial experiment in order to study three designed parameters. Appropriate data were collected and statistically processed via analysis of mean responses as well as of Signal-to Noise Ratio (S/N), resulting to the determination of optimal settings of the critical design parameters. The obtained result shows that the optimum setting parameter of the factors is proposed the condition of $A_1B_2C_2$. Additionally, it also found that baking duration as the most significant factor that affect the quality characteristic in this project. The justification experiment is show the optimal setting parameter improves the acceptable quantity of the bread. At the end of this study, some suggestion and recommendation is proposed to improve the quality of the manufactured product of XXX Enterprise is suggested.

DEDICATION

For my beloved parents:

Mr. Ahmad Jawahir bin Tugimin

Mrs. Sapiah binti Surif

For my supportive siblings:

Nurul Ain binti Ahmad Jawahir

Ahmad Saufi bin Ahmad Jawahir

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~ Bismillahirahmanirrahim ~

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LIST OF ABBREVIATIONS

ANOVA	-	Analysis of Variance
df	-	defect
DOE	-	Design of Experiment
ECL	-	Electrical Communications Lab
OA	-	Orthogonal Array
ov	-	overcook
PDCA	-	Plan, Do, Check, Act
rp	-	unripe
QFD	-	Quality Function Deployment
SME	-	Small Medium Enterprise
S/N	-	Signal to Noise
ta	-	total accepted
TA	-	Grand Total Accepted
TDF	-	Grand Total Defect
TOV	-	Grand Total Overcook
TQM	-	Total Quality Management
tr	-	total reject
TR	-	Grand Total Reject
TRP	-	Grand Total Unripe

CHAPTER 1
INTRODUCTION

This chapter is to provide background information of the study and general idea of the project. There are five sections cover in this chapter which is background of study, problem statement, objectives, scope and structure of the case study.

1.1 Background

Refers to Adam *et al*., (1981), that quality is the degree to which a product or service conforms to a set of predetermined standards related to the characteristics that determine its value in the market place and its performance of the function for which it was designed. While Harry *et al*., (2010:5) stated that quality is a perceptual, conditional and somewhat subjective attribute. Here means that although numerous definitions and methodologies have been created with many different techniques and concepts that have evolved to improve product or service quality, but there are two common quality-related functions within a business. One is quality assurance which is the prevention of defects, such as by the deployment of a quality management system and preventative activities like FMEA. The other is quality control which is the detection of defects, most commonly associated with testing which takes place within a quality management system typically referred to as verification and validation.

Specifically, Meirovich*et al.*, (2007:242-243) stated that the design quality is the degree to which a product or service‘s design (specification) fits customer needs and expectations, while conformance quality is the degree of match between the features of a specific product (service) and its specification. This is the customers‘

expectation that is focused on the specification quality of a product or service, or how it compares to competitors in the marketplace. So, producers might measure the conformance quality, or degree to which the product or service was produced correctly meets the specification.

However, in current of a constantly changing global business environment, main aspect of competitiveness is the continuous quality improvement. There are not only to correctly meet the specification. As an example: the product. By reduction of variability as well as other failure of products in order to maintain economic viability by the implementation of statistical technique for quality control is also consume the cost. Therefore, to reduce of variability as well as other failure of products then the business or company should focus their concern through the development of extensive carefully planned experimentation at the design stage of products or processes. This is as what argued by Unal and Dean (1991:1) that the quality engineering methods of Dr. Taguchi by employing design of experiments (DOE) is as one of the most important statistical tools of TQM for designing high quality.

Here, although Design of Experiments (DOE) is the method to minimizing process variation and reducing rework, scrap and the need for inspection systems at reduced cost, but the term of experiment in this concept is to define the systematic procedure carried out under controlled conditions in order to discover an unknown effect. Genichi Taguchideveloped this concept to improve the quality of manufactured goods, and more recently also applied to engineering, biotechnology, marketing and advertising.It is the element that common and successful in integrating the statistical methods into the powerful engineering process for process optimization problems.DrGenichi Taguchi states the concept of "*Uniformity around a target value*." The idea is to lower the standard deviation in outcomes, and to keep the range of outcomes to a certain number of standard deviations, with rare exceptions. A number of successful application of Taguchi method of experimental design for improving product quality and process performance have been reported by many US and European manufactures over the last 15 years (Antony&Preece, 2002:82).

Taguchi concert based on off-line quality control that enables the product development process is followed in a quality manner and produces a quality product

or process at the lowest possible cost(Hundy, 1991:51). Based on an understanding of the loss function and complete through three stages which are system design, parameter design and tolerance design, the involvement of element-element in these three stages are accumulated of the creativity and innovation to make detail design in order reducing and controlling variation in the critical few dimensions. Hence, the online quality control function during manufacturing and service after the sale effort are therefore reduced. This saving can be considerable and is worth the effort involved in learning the Taguchi philosophy.

The Taguchi‘s method implementation is already developing based on food manufacturing process such as in optimization of the mixing ingredient of cake. Refer to Besseris (2009:342) that the mixture factors for cake processing should obey to have forced the development of mixture optimization problems to a different course comparing to the mainstream regression type of methods or other ordinary type fractional factorial treatments. Mixture constituents are expressed in terms of a physical entity which often is expected to be either their mass or their volume contribution. The result shows that the non-linear orthogonal arrays may be employed to economize time-consuming mixture experiments in food industry. The analysis methodology proposed here was a combination of nonparametric for processing collected data from the $L_9(3^4)$ fractional factorial while the slack variable was treated opting for either the standard nonparametric correlation technique of Spearman's ρ or for classical regression fitting.

1.2 Problem Statements

In the Small Medium Enterprise (SME)food manufacturing industries, the manufacturing process runs with the traditional ways (Dhungana, 2003:11; Sha‘ri, 2003:10&16). This is due to the skill and knowledge of operators. There are also found due to limited implementation of management system and quality control towards their product that was produced to meet the specification.

In XXX Enterprise, the process flow shows the two of the machine influences to the quality of the product. The problem was happened during setting the parameter of the

machine used to meet the specification of the end of the product. What the company runs against their production system solely depend on the visual inspection method to confirm the specification. Also,the parameter used in their production system is merely supplier suggestion for their manufacturing process. Therefore, to produce the good quality of food product is still inconsistent due tothe defects of product was still found in each of trays that related to the currentmachine parameters, which the kind of defects are dueovercooked or unripe.

The challenge in conducting the study is the systematic setting parameter arrangement of controlled environment to provide the stable condition of experiment. This is to avoid the impact of external factor that influenced to the control factors. Fotis*et al*., (2008) state that the clean weight and surface peak measurement are both quantitative responses and their values can provide with a significant indication of the effectiveness of the ingredients‘ amount to the final product output. Besides, the designs of process parameters that should be remain constantly in order to keep the mixing quantity of ingredient are follow the standard.

1.3 Objectives of the Study

The objectives of this case study are as follow

(a) To identify the parameter factors that affects to the quality of food (bread) manufacturing process.
(b) To analyze and determine the optimal parameter factors of food manufacturing process by using Taguchi Method.
(c) To suggest the improvement of quality and productivity in SME food manufacturing company.

1.4 Scope

The focus of this study is to investigate on how to improve the quality of bread products in XXX Enterprise. The parameters that having significant impact on process performance therefore is needs to be identified through systematic experimental design approach. By using Taguchi method, the optimal setting of bread product processing is determined especially, towards the parameters of the mixing machine and the infrared-oven machine.

1.5 Organization of the Project

Based on the Project SarjanaMuda (PSM) 1, the organization of the process flow case study is constructed. This organization is the guideline for students follow the formats and understands the sequences of doing the project respectively. The format of organization as follow:

(a) Chapter 1: Introduction

This chapter described the background of Taguchi‘s method, objectives of the study, problem statement, and scope of study and the organization of the project.

(b) Chapter 2: Literature review

This chapter summarized all the theory, information, opinion and finding that related to the quality improvement by using Taguchi‘s method. The source of the information is gathering from journals, book, internet, articles and etc.

(c) Chapter 3: Methodology

This chapter describes the overview of the research methods. It refer to the way of method selection to conduct the research to solve the problem in term of data collection, tools, techniques used for the analysis and solved the problem for better improvement.

(d) Chapter 4: Result and Discussion

This chapter covers the result after the researched is done. The data collection for quality assurance and controlled parameters are collected. This is continuing by detailed analysis on the data collected to find out the problem. Process

parameters that contribute to the most defects on finished parts are selected. Then, the result of findings and outcomes is discussing more detail. It is related to the theory and current understanding in quality improvement. The discussion contain the controlled parameters that caused defects on the products and selected technique used to solve the current problem faced by using Taguchi‘s method to improve the quality.

(e) Chapter 5: Conclusion and Recommendations

This chapter included the recommendation and summary of the study. Quality improvement conducted in this chapter for the further study related to Taguchi‘s method. Recommendations will be suggested at the end of this chapter.

CHAPTER 2
LITERATURE REVIEW

This chapter contains the literature review of the study which relates to the scope of the study. It covers the definition of quality, quality improvement, Taguchi's background, history of Taguchi's method and its approaches and more focusing on methodology in Taguchi's method. Sources of information were obtained from journals, books, case studies, reports and also electronic-media sources. Each source was selected based on the similarity with the scope of the study.

2.1 Definition of Quality

Quality is a perceptual, conditional and subjective attribute that defining differently by different people.Manouselis and Costopoulou (2006: 219) stated that quality is defined as the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs. The customer will be pleased and consider that the product is of acceptable or even high quality if a product meets the customer's expectations. Otherwise, the customer will consider that the product is low quality. This means that the quality of a product may be defined as ~~"it~~s ability to fulfill the customer's needs and expectations". Quality is a multidimensional and subjective concept. Quality means different things to different people (Blanchet, 2005:7). Refer to Chartered Quality Institute (2010), state that quality is the result of a comparison between what was required and what was provided. It is judged not by the producer but by the receiver. The judgment can be made of an intention, as is the case when selecting suppliers, or an output, as is the case when purchasing a product or service. Quality is related with customer, that describes the feedback from the customer indicate the quality measurement. The consideration in quality

measurement from customer is to fulfill the customer requirements and customer expectations.The products should haveseveral characteristics such as reliable, useable, and repairable. Similarly, service should beefficient and effective. The most important qualities are the ones that customers want, providing quality products and services meeting customer requirements. This focused on meeting the needs and expectations of customers.

Refer to Khan and Zhang (2008: 9&10), the definition of quality also is defined by some of quality gurus. Their research in quality term is described:

Table 2.1: Definition of quality from quality gurus

Advocate	Year	Definition of quality
Walter Shewhart	1931	*"...there are two common aspects of quality. One of these has to do with the consideration of the quality of a thing as an objective reality independent of the existence of man. The other has to do with what we think, feel or sense as a result of the objective reality. In other words, there is a subjective side of quality".*
Joseph Juran	1951	*"Fitness for use".*
Philip Crosby	1979	*"Conformance to requirements".*
Genichi Taguchi	1979	*"The losses a product imparts to the society from the time the product is shipped".*
Edwards Deming	1985	*"Quality should be aimed at the needs of the customer, present and future".*
Myron Tribus	1990	*"Quality is what makes it possible for a customer to have a love affair with your product or service."*
ISO 9000: 2000	2000	*"The degree to which a set of inherent characteristics fulfills the requirements, i.e. needs or expectations that are stated, generally implied or obligatory".*
BengtKlefsjo and Bo Bergman	2004	*"The quality of a product is its ability to satisfy, and preferably exceed, the needs and expectations of the customers".*

2.2 Definition of Quality Improvement

The Juran Trilogy defined quality improvement as the process for creating breakthrough levels of performance by eliminating wastes and defects to reduce the cost of poor quality. It contain prove the need for improvement, identify the improvement projects and establish project improvement teams. It provides the project teams with resources, training, and motivation to diagnose the causes, stimulate the remedies and establish controls to hold the gains (Claire *et al*., 2005). Continuous improvement is a management philosophy based on employees' suggestions. It was developed in the United States at the end of the nineteenth century. Nevertheless, some of the most important improvements took place when this idea or philosophy arrived in Japan. Japan was already using tools such as quality circles, so when Japanese managers combined these two ideas, *kaizen* was born.

Chan and Sha'ri (2009: 44), state thatquality improvement is crucial for manufacturing companies to survive in today's marketplace. The quality gurus, Deming also encouraged a systematic approach to problem solving and promoted the widely known Plan, Do, Check, Act (PDCA) cycle. The PDCA cycle is also known as the Deming cycle, although it was developed by DrShewhart. This idea being to constantly improve reduces the difference between the requirements of the customers and the performance of the process. The cycle is about learning and ongoing improvement in the cycle process.

Figure 2.1: PDCA cycle