UNIVERSITI TEKNIKAL MALAYSIA MELAKA

QUALITY IMPROVEMENT USING FACTORIAL DESIGN (A CASE STUDY IN MANUFACTURING COMPANY)

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

by

UMIE ROSMIDA BINTI MAMAT
B051310281
940910-11-5588

FACULTY OF MANUFACTURING ENGINEERING
2017

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **QUALITY IMPROVEMENT USING FACTORIAL DESIGN: A CASE STUDY AT MANUFACTURING COMPANY**

SESI PENGAJIAN: **2016/2017 Semester 2**

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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 the degree of Bachelor of Manufacturing Engineering (Manufacturing Management) (Hons.). The members of the supervisory committee as follow:

.....

(DR NADIAH BINTI AHMAD)

.....

(PROF. MADYA DR. LUKMAN SUKARMA)

ABSTRAK

Dalam organisasi, penambahbaikan kualiti untuk produk harus dikekalkan supaya dapat menghasilkan perkhidmatan yang terbaik kepada pelanggan. Tujuan projek ini dijalankan adalah untuk menambahbaikan kualiti keropok keping dengan memaksimumkan bilangannya dalam bentuk tekstur yang baik. Projek ini memilih tekstur sebagai penunjuk aras kerana ia meliputi seluruh keadaan keropok keping itu. Projek ini dimulakan dengan menganalisis setiap proses untuk mengenalpasti potensi kerosakan atau masalah. Proses yang terlibat dalam kerosakan produk adalah proses pencampuran, proses pendidihan dan proses pengeringan. Melalui pemerhatian di setiap proses, faktor atau senarai input dipilih iaitu kuantiti kanji, masa yang diambil untuk proses pendidihan dan masa yang diambil untuk proses pengeringan. Faktor-faktor yang dipilih harus mempunyai aras rendah dan aras tinggi untuk menjalankan eksperimen. Seterusnya, teknik rekabentuk factorial digunakan untuk meneruskan projek. Tujuan teknik ini adalah untuk membina rekabentuk eksperimen dan mengenalpasti setiap interaksi dalam setiap pembolehubah. Projek ini mengunakan rekabentuk factorial penuh, 2^3 dengan dua pengulangan. Lapan eksperimen dijalankan bagi setiap pengulangan. Seterusnya, keputusan daripada eksperimen akan dianalisis mengunakan perisian Minitab. Dengan itu, keputusan daripada ANOVA, model regrassi dan keputusan graf boleh didapati dengan jayanya. Selepas itu, tetapan yang optimum untuk faktor-faktor yang dipilih dapat ditentukan. Tetapan yang optimum diperolehi apabila mengunakan aras rendah untuk kuantiti kanji dan aras tinggi untuk masa yang diambil dalam proses pendidihan dan masa yang diambil untuk proses pengeringan. Akhirnya, melalui keputusan yang diperoleh beberapa saranan diperkenalkan kepada SME untuk menambahbaikan kualiti produk yang memberikan prestasi yang baik kepada syarikat.

ABSTRACT

In organization, the quality improvement of the product should be consistent in order to produce a better service for the customer. The purpose of this project is to improve the quality of fish crackers by maximizing the number of yield in term of its good texture. This project chooses the texture as indicator because it covers all the condition of fish crackers. The project commences with analyze in each process to find a potential defects or failures. The process that contributes to defect are mixing process, boiling process and drying process. Based on observation, the factors or input variables suspected to influence texture of fish crackers are quantity of cornstarch, duration of boiling process and duration of drying process. Each selected factors are set to low level and high level to conduct the experiment. Next, factorial design method is implemented. The purpose of this method is to build the design of experiment and identify interactions in each variable. This project used full factorial design, 2^3 with two replications. Eight experiments will be run for each replication. Then, the result from the experiment will be analyzed by using Minitab software. From there, the result of ANOVA, regression model and graphical method can be obtained successfully. After that, the optimum setting for selected factors can also be determined. It is found that optimum setting is obtained when quantity of cornstarch, duration of boiling process and duration of drying process are set at low level, high level and high level respectively. Finally, based on the results, recommendation is established to the SME for improving the products quality that lead to the better performance of the company.

DEDICATION

Special dedicate to my beloved parents, Mamat Bin Ismail and Ramlah Binti Jusoh that encourage me to believe in hardwork. To my siblings for giving me moral support.

To my supervisors, Prof Dr Lukman Sukarma and Dr Nadiah Binti Ahmad. Thanks for your guidance, helps and cooperation.

Lastly, to my friends that always be my side to help and give useful suggestion regarding this project. Thank You So Much & Love You All Forever.

ACKNOWLEDGEMENT

Firstly, I would like to express my sincerest appreciation to my supervisor Professor Madya Dr. Lukman Sukarma and Dr Nadiah Binti Ahmad who entrust to give this project to me, give guidance, encouragement and criticism how to perform in this project. Working under them made a substantial contribution to my academic field. Their insightful suggestion for completing this project helps me understand the detail of project deeply.

I am also very grateful to the owner of the Small Manufacturing Enterprise (SME) En Razif bin Abdullah that willing to give me a chance to conduct an experiment there. He introduce all the workers there and being very helpful and supportive especially during the experiment is run. I would like to thank to all workers there that willing to share their knowledge and give very useful information to me regarding to this project.

My special thanks to my family for their helps that introduce me to the owner of the SME. In addition, big appreciation to their support in term of mentally and financial, encouragement and sacrifice. Lastly, I would like to thank all my friends that help me in completing this project.

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LIST OF ABBREVIATIONS

ANOVA	-	Analysis of Varience
CI	-	Confidence Interval
DOE	-	Design of Experiment
SME	-	Small Manufacturing Enterprise

LIST OF SYMBOLS

α	-	Alpha
%	-	Percentage
Kg	-	Kilogram

CHAPTER 1
INTRODUCTION

Chapter 1 is about general information for the project with the title of Quality Improvement using Factorial Design that conducted in manufacturing company. This chapter provides four sections such as background of project, problem statement, objectives and research scope.

1.1 Background of Project

In the competitive world of industry,it is very high in preparing the best service to customers. Thus, the company must maintain or control the quality of the product because it has a important role. Nowadays, a lot of competition in business field, so anyone that want to grow their business must work hard to seek new opportunities in terms of best quality need to be maintained or developed into a better ways. Sahno and Shevtshenko (2014) claimed that, the better quality of product will lead to better performance of the company. Moreover, the profits of company automatically can be increased in a large range if they able to manage their product quality in a perfect way. A good quality of products can be obtained through the eliminated or control the bad factors.

There is a considerable issue about quality in manufacturing company or organization. In order to do an improvement of the quality product, factorial design is a suitable method. Based on Cristovao *et al.* (2015), a factorial design of trials has been broadly used to process development and optimization in light of the fact that it permits the

simultaneous examination of the impacts of many process factors at various levels and analyze an interaction. After all possible parameters or factors were decided, some techniques can be applied to get the solution like using Excel, Minitab and Design Expert Software. After that, ANOVA (Analysis of Variance) table will be appeared that act as a conclusion of the experiment. According to Kumar *et al.* (2015a) ANOVA will show an importance effect of independent factors and able to translated into graph plot.

The effectiveness of factorial design method can be shown through this project. This project was conducted at Small Manufacturing Enterprise (SME) that located at Kuala Terengganu. In this case, all process to produce the fish cracker was investigated to identify which parts can lead to the poor quality of fish cracker. Then, determine the selected factors that produce the maximum yield of fish crackers with good texture. The selected factors are quantity of cornstarch, duration of boiling process and duration of drying process. Lastly, the result of the project can be obtained using factorial design.

1.2 Problem Statement

Food industry is different from others manufacturing industry. This is because, to control the failure happen in other industries, alternatives ways are provide such as rework or repair in order to achieve the products specification. However, in food industries 100% the product can be classified as wasted products if there are failures happen. In that SME, they produce a fish cracker in semi-auto way, means that 70% uses a man power and 30% uses a machine. This small enterprise has been operated about one and half years. In order to compete with others organization, they want to improve their sales by producing a good quality of fish crackers. The discussion and experiment were held at the small enterprise. Then, able to find the critical process by investigate in each step of producing fish crackers. There are three critical processes that able to give bad quality for fish crackers which are mixing process, boiling process and drying process. The experiment was carried out by using that sample size and the data is shown as Table 1.1.

Quality of the food also can be controlled by determine the right quantity of materials needed. This organization only has a small size of mixer machine. So, quantity for fish fillet is fixed to 5kg for each mixing process. The problem happens when to analyze the suitable amount of cornstarch that must be matched with the fish fillet. This is because, there is no specific amount of cornstarch should be put, they only assume for each run. Quantity of cornstarch need to control because according to the expert worker here it is can affect the texture of fish crackers. In order to identify right quantity of cornstarch, an experiment was conducted by using +/- from standard measurement (4 to 6 kg) and got the observation. (Table 1.1)

Many methods are provided to cook fish cracker but they tend to use boiling process rather than steam process for serve a good quality of food. However, the texture of fish crackers still not fulfills the customer requirement. This is might due to undetect duration for fully cook of fish crackers. The workers use traditional method which takes out the fish crackers from the boiling water if it is floating on boiling water. Unfortunately, this method is not too effective due to sometime it is still not fully cook. So, when it is happen the texture will easy to break.

Lastly, during the drying process, duration of fish crackers to get dry also is an important role in producing a good texture of fish crackers. In hot weather, the fish crackers will dry in the optimal range. However, in a bad condition of weather such as rainy or cloudy, it is will influence the texture of the product. The texture becomes easy to break and stick with others slice. Thus, in order to obtained the exactly duration for drying process, factorial design method is used by improve the quality of fish crackers in term of texture.

Table 1.1: Observation for each process of Fish Crackers

Process	Sample Size	Observation
Manually clean the fish	5kg of fresh fish	The workers take the fresh fish one by one to make sure it is properly clean.
Store in the freezer	5kg of clean fish	Using suitable temperature for keep it in the freezer. There is no problem obtained.
Manually seperate the fish bone	5kg of clean fish	The fish fillet can be seperated without having a problem.
Mix the ingredients into mixer machine	5 kg-fish fillet 160 g-Salt 100 g- Sugar 16 g- MSG 1.3 kg- Ice water 4 kg- cornstarch 6 kg- cornstarch	In this small enterprise there is no range of cornstarch quantity provided but put it as assumption. In order to identify which quantity of cornstarch bring poor quality of fish crackers, two experiment were run based on quantity of cornstarch. a. Below than 4 kg quantity of constarch Texture of fish crackers too soft, color not attractive (too dark), not expand when fried. b. Higher than 6 kg quantity of cornstarch Texture of fish crackers too hard, color not attractive (too bright), tasteless.
Kneading the dough (manually)	Fish fillet mix with cornstarch	They will knead ing the dough manually. Each stick contain 2kg of fish crackers dough. Before proceed to knead process, they will weight the dough first.
Boiling process	10 stick of fish crackers	Take out the fish crackers when it is floating on boiling water: 6/10 – fish crackers fully cooked 4/10 – fish crackers half cooked
Store in the freezer	10 stick of fish crackers	Using suitable temperature for keep it in the freezer. There is no problem obtained.
Cutting process	10 stick of fish crackers	The cutting of fish crackes can be controlled by using a cutter machine.
Arrange the fish cracker into “bidal”	10 stick of fish crackers	Fish crackers must be arranged slice by slice to avoid they stick to each others.

Drying process	Duration drying process for: a. Less than 6 hours b. More than 8 hours	Duration of drying process that has been decided by this small enterprise in the range of 6 to 8 hours. To determine either more or less than the range of time that can lead to low quality of fish crackers, two experiments were carried out: a. Less than 6 hours Condition of fish carakers: Texture (soft) stick with others slice, easy to broke and smelly b. More than 8 hours Condition of fish crackers: Texture (hard) and easy to store or package

Figure 1.1 shows the yield of fish cracker produce with good quality versus bad quality (percentage) in four week for August 2016.

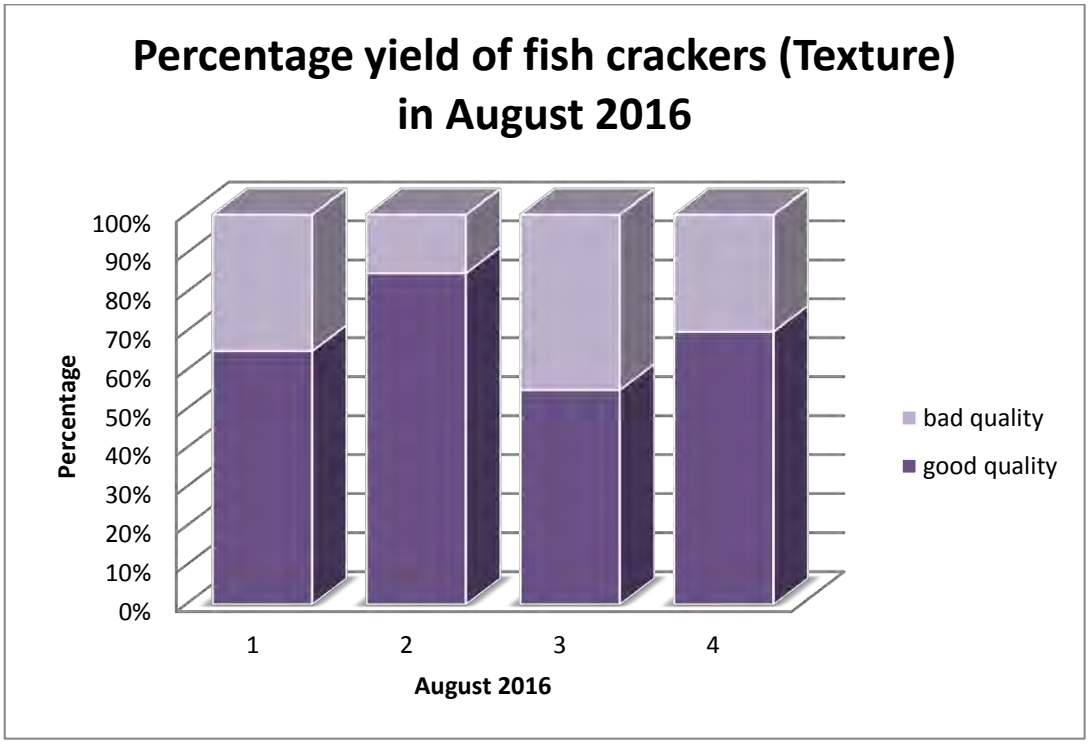

Figure 1.1: Graph for Percentage of yield fish crackers in term of its texture in August 2016

Overall observation from Figure 1.1 is indicating the bad quality of fish crackers occur at every week in August 2016. The highest percentage occurs at week 3. It is might due to the usage of wrong parameter for quantity of cornstarch, duration of boiling process and duration of drying process.

1.3 Objectives

The aim of this study is to provide the best solution in quality for fish cracker according to it process. Thus, the main objectives as stated below:

i. To investigate the factors or input variables that creates the maximum yield of fish crackers with a good texture.
ii. To implement Factorial Design in the experiment and analyze result through the usage of Minitab 17 Software.
iii. To determine the optimum setting depend on result obtain from experiment for producing better quality of fish crackers.

1.4 Scopes

This project is conducted at a small enterprise of food industries that produce fish crackers. In producing fish crackers, there are some defects happen that leads to the poor quality of product produces. Thus, the scopes as shown as below:

i. Observe the maximum yield of fish crackers with good texture in production line.
ii. Control the input variables or factors at mixing process, boiling process and drying process.

CHAPTER 2
LITERATURE REVIEW

Chapter 2 is about the research that has been carried out by other people with gives some information of this project. From the reading, student able to get the idea for conduct the project.

2.1 Design of Experiment (DOE)

According to Patel *et al.* (2016), Design of Experiment (DOE) is a necessary piece of analytic quality by design. The analytic that incorporate of experimental design, mathematical model generation by ANOVA analysis, graphical form, show correlation between factors and response. Besides, DOE will able to study how factors affecting the method and defining a robust.

Rekab and Shaikh (2005a), claimed that experimental design is a test that conducting in an experiment to identify vital input variables and observe it which changes needed or not. This is needed to produce an excellent output response. The goals and outline of the Design of Experiment as shown as below:

Goals:

- Improve process yields (outcomes)
- Find factors that affect the average response (location).
- Find factors that affect the variability (dispersion).

- Find factor setting that optimizes the average response (parameter optimization).
- Find factor setting that minimizes variability.
- Reduce development time.
- Reduce overall cost.

Outline:

- Determine the objective of the experiment.
- Determine the response.
- Determine the factors and the region of interest.
- Determine the settings of the factors.
- Perform the experiment.
- Perform statistical analysis.
- Draw practical conclusion and give recommendations.

2.1.1 Purpose of Experimental Design

Lawson (2010a) stated that prescription for successful application of the scientific method is the one of the reason for usage of experimental design. There are scientific methods contain of iterative application of the following steps:

i. Find the state of nature
ii. Conjecturing or hypothesizing the mechanism for what has been find
iii. Take the data
iv. Conduct an analysis to confirm or reject the conjecture

Through the experimental design, plan for collecting data is provided such as collect it in a way that they can be observed statistically to corroborate the conjecture in question. When an experimental design is used, the conjecture must be stated clearly and a list of the experiments proposed in advance to provide the data to test the hypothesis. So, these methods able help to prevent false starts and incomplete answer to research questions.