DESIGN AND DEVELOPMENT OF DRIED CHILI SEEDS SEPARATOR MACHINE USING DFMA METHODOLOGY

This Final Project Has Been Arranged as a Requirement to Complete Bachelor Degree Program in Mechanical Engineering Department at Engineering Faculty

Submitted by:

MUHAMMAD ZIYAN RIZQIN
D200133002

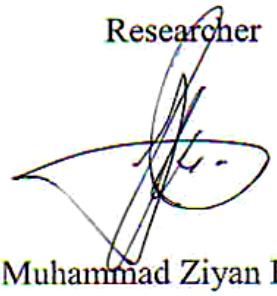
INTERNATIONAL PROGRAM
MECHANICAL ENGINEERING DEPARTMENT
ENGINEERING FACULTY
UNIVERSITAS MUHAMMADIYAH SURAKARTA
2018

DECLARATION OF RESEARCH AUTHENTICITY

I hereby, declare this final project entitles “DESIGN AND DEVELOPMENT OF DRIED CHILI SEEDS SEPARATOR MACHINE USING DFMA METHODOLOGY” is the results of my own research which has been arranged as a requirement to complete the degree of Bachelor of Engineering program in mechanical engineering department at engineering faculty of Universitas Muhammadiyah Surakarta,except as cited in the reference that used to solve the problem.

Surakarta, 8 December 2018

Researcher



Muhammad Ziyan Rizqin

D200133002

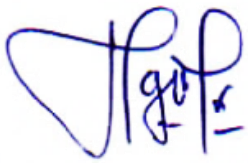
APPROVAL

The final project entitles “DESIGN AND DEVELOPMENT OF DRIED CHILI SEEDS SEPARATOR MACHINE USING DFMA METHODOLOGY" has been approved by supervisor as partial fulfillment of the requirement to complete the degree of Bachelor of Engineering program in mechanical engineering department at engineering faculty of UniversitasMuhammadiyah Surakarta.

Name : Muhammad Ziyan Rizqin
NIM : D200133002

Has been approved and legalized on
Day : Saturday
Date : 8 December 2018

Approved to be examined by
Supervisor



AgusDwiAnggono, ST, M.Eng, Ph.D

VALIDATION

The final project entitles “DESIGN AND DEVELOPMENT OF DRIED CHILI SEEDS SEPARATOR MACHINE USING DFMA METHODOLOGY" has been defended in front of examiners team and approved as partial fulfillment of the requirement to complete the degree of Bachelor of Engineering program in mechanical engineering department at engineering faculty of Universitas Muhammadiyah Surakarta.

Name : Muhammad Ziyan Rizqin

NIM : D200133002

Has been approved and legalized on

Day : Saturday

Date : 8 December 2018

Team of Examiners

Head of Examiner :

Agus Dwi Anggono, S.T, M.Eng, Ph.D (.....)

Member of Examiner I :

Dr. Muhammad Syukron (.....)

Member of Examiner II :

Wijianto, S.T, M.Eng.Sc (.....)

Dean of
Engineering Faculty

Ir. Sri Sunarjono, M.T.,Ph.D.,IPM

Head of
Mechanical Engineering

Ir. H. Subroto, M.T

DEDICATION

Alhamdulillahi rabbil'alamin, this final project expresses the highest gratitude to Allah SWT and Prophet Muhammad SAW, for blessing, guidance, love, opportunity, health and mercy to complete the degree of bachelor of engineering in mechanical engineering department at engineering faculty of Universitas Muhammadiyah Surakarta. This final project is dedicated to:

1. dr. Agus Pramono and Lilis Fatmawati as my beloved parents, Anisa Shabrina S.E, Afina Naufal S.Farm, Medina Nur Jehan as my beloved sisters that always help and support me in hard times and thanks for love, guidance, affection, prayer, and everything that has been given to me.

MOTTO

Innovation distinguishes between a leader and a follower (Steve Jobs)

Innovation is the only way to win (Steve Jobs)

Innovation is taking two things that already exist and putting them together in a new way (Tom Freston)

There is no innovation and creativity without failure (Brene Brown)

Imagination is more important than knowledge. Knowledge is limited. Imagination encircles the world (Albert Einsten)

Failure is an option here. If things are not falling, you are not innovating enough (Elon Musk)

There is always room to improve (Muhammad Ziyan Rizqin)

Failure is not the end but it is the first steps to improve (Muhammad Ziyan Rizqin)

Everyone have their own timeline. Just believe what you do and focus. (Muhammad Ziyan Rizqin)

ACKNOWLEDGEMENTS

Assalamu'alaikum. Wr. Wb

Alhamdulillahirabbil'alamin. Praise for the presence of Allah SWT and the prophet of Muhammad SAW due to his permission the author has completed the final project which the title is "DESIGN AND DEVELOPMENT OF DRIED CHILI SEEDS SEPARATOR MACHINE USING DFMA METHODOLOGY". On this occasion, the author would like to thanks:

1. Ir. Sri Sunarjono, M.T, Ph.D, IPM, as the dean of Engineering Faculty of Universitas Muhammadiyah Surakarta.
2. Ir. H. Subroto, M.T, as the head of Mechanical Engineering of Universitas Muhammadiyah Surakarta.
3. Agus Dwi Anggono, S.T, M.Eng, Ph.D, and Dr. Mohd Fahrul Bin Hassan, as supervisor who have given inspiration, spirit, advices, suggestions, and corrections to the final project completion.
4. Wijianto, S.T, M.Eng.Sc, as the head of Automotive Engineering Double Degree Program of Universitas Muhammadiyah Surakarta and academic supervisor, who has given advices ad support.
5. All of lecturer of Mechanical Engineering Department of Universitas Muhammadiyah Surakarta and Universiti Tun Hussein Onn Malaysia.
6. My beloved father, mother, sisters, all of my family and my friend, who have been providing support, advices and jokes.

The author realizes that this final project is still not perfect. Therefore, constructive criticism and suggestions are welcome.

Wassalamu'alaikum. Wr. Wb.

Surakarta, 8 December 2018

Muhammad Ziyan Rizqin

ABSTRAK

Merancang suatu produk yang memiliki sedikit komponen, mudah dirakit, dan biaya produksi rendah sangat penting untuk tim perancang agar berhasil dalam pasar daya saing global. Oleh karena itu, metodologi DFMA dianggap dan banyak digunakan untuk mengatasi masalah tersebut. DFMA adalah metode yang didasarkan pada DFA dan DFM untuk memastikan produk dirancang untuk mudah diproduksi dan dirakit dengan minimum waktu dan biaya perakitan, dan biaya produksi.

Tujuan dari tugas akhir ini adalah untuk menentukan jumlah total komponen, TN_i, total waktu perakitan, TT_{ma}, dan biaya, TC_{ma}, kualitas perakitan, D_a, efisiensi desain, biaya total bahan, TM_c, total biaya pemrosesan dasar, TP_c, total koefisien biaya relatif, TR_c, total biaya manufaktur, TM_i. Produk desain yang telah ada dan yang diusulkan akan dianalisis dengan menggunakan metodologi DFMA. Perangkat lunak Solidworks digunakan untuk merancang setiap komponen dari produk yang ada dan untuk mengembangkan produk baru. Motor listrik dan analisis simulasi produk digunakan untuk memverifikasi apakah produk aman dan dapat dioperasikan dengan baik.

Berdasarkan hasil penelitian ini dapat disimpulkan bahwa desain produk mesin pemisah biji cabai kering yang ada sudah diperbaiki sehingga terjadi pengurangan sebesar 93,62% pada jumlah total komponen, TN_i. Total waktu perakitan, TT_{ma}, berkurang 95,93%. Total biaya perakitan, TC_{ma}, berkurang 95,88%. Efisiensi desain ditingkatkan dari 80,85% menjadi 22,22%, pengurangan 93,62%. Kualitas perakitan, D_a, ditingkatkan, dari 14,62% menjadi 0,45%. Total biaya material, TM_c, berkurang, dari 8881.33 menjadi 630.53 pence, pengurangan 92.90%. Total biaya pemrosesan dasar, TP_c, berkurang, dari 406,40 menjadi 121,40 pence, pengurangan 70,13%. Koefisien total biaya relatif, TR_c, berkurang dari 291,89 menjadi 134,56 pence, penurunan 53,90%. Total biaya produksi, TM_i, berkurang 85,06%, dari

12189,63 menjadi 2478,07 pence. Torsi, T, motor terpasang adalah 0,64 Nm yang lebih tinggi dari torsi, T, motor yang dibutuhkan adalah 0,58 Nm. , tekanan minimum adalah 1,367e + 003 $\mathrm{N/m^2}$ dan tegangan maksimum adalah 2,562e + 006 $\mathrm{N/m^2}$. Ketegangan minimum adalah 5.609e-007 dan regangan maksimum adalah 1.051e-003. Faktor keamanan minimum adalah 1,859e + 001 dan faktor keamanan maksimum adalah 3,483e + 004. Oleh karena itu, secara teoritis desain baru mesin pemisah biji cabai kering ini aman dan dapat dioperasikan dengan baik.

Kata kunci: Produk Desain, Mesin Pemisah Biji Cabai Kering, DFMA, DFA, DFM.

ABSTRACT

Designing the product that has few parts, easy to assemble, and low manufacturing cost is essential to design team in order to be successfully in global competitiveness market. Therefore, DFMA methodology is considered and widely used to overcome those problems. DFMA is a method based on DFA and DFM to ensure the product is designed to easily and efficiently manufactured and assembled with a minimum assembly time and cost, and manufacturing cost.

The purposes of this final project are to determine the total number of parts, TN_i, total assembly time, TT_{ma}, and cost, TC_{ma}, assembly quality, D_a, design efficiency, total material cost, TM_c, total basic processing cost, TP_c, total relative cost coefficient, TR_c, total manufacturing cost, TM_i. The existing and the proposed design product are analyzed by using DFMA methodology. Solidworks software is used to design of each component of the existing product and to develop the new products. Electric motor and product simulation analysis is used to verify whether the product is save and can be well operated.

Based on this research results can be concluded that the existing product design of dried chili seeds separator machine was improved resulting a reduction of 93.62% in total number of parts, TN_i. The total assembly time, TT_{ma}, was reduced by 95.93%. The total assembly cost, TC_{ma}, was reduced by 95.88%. The design efficiency was improved from 80.85% to 22.22%, a reduction of 93.62%. The assembly quality, D_a, was improved, from 14.62% to 0.45%. The total material cost, TM_c, was reduced, from 8881.33 to 630.53 pence, a reduction of 92.90%. The total basic processing cost, TP_c, was reduced, from 406.40 to 121.40 pence, a reduction of 70.13%. The total relative cost coefficient, TR_c, was reduced from 291.89 to 134.56 pence, a reduction of 53.90%. The total manufacturing cost, TM_i, was reduced by 85.06%, from 12189.63 to 2478.07 pence. The torque, T, of installed motor is 0.64 Nm which is higher than the torque, T, of required motor is 0.58 Nm. , the minimum stress is 1.367e+003 $\mathrm{N/m^2}$ and the maximum stress is

2.562e+006 N/m^2. The minimum strain is 5.609e-007 and the maximum strain is 1.051e-003. The minimum factor of safety is 1.859e+001 and the maximum factor of safety is 3.483e+004. Therefore, theoretically the new design of dried chili seeds separator machine is save and can be well operated.

Keywords: Design Product, Dried Chili Seeds Separator Machine, DFMA, DFA, DFM.

CONTENTS

CHAPTER 1 INTRODUCTION

CHAPTER 2 LITERATURE REVIEW

LIST OF FIGURE

LIST OF TABLE

LIST OF EQUATION

LIST OF SYMBOL

N_i	- Number of items
TN_i	- Total number of parts
H_t	- Estimated handling times
l_t	- Estimated insertion times
T_{ma}	- Operation time per component
TT_{ma}	- Total assembly time
C_{ma}	- Operation cost per component
TC_{ma}	- Total assembly cost
D_a	- Assembly quality or probability a defective assembly
V	- Volume
V_f	- Finished volume
M_c	- Material cost
T_{mc}	- Total material cost
P_c	- Basic processing cost
TP_c	- Total basic processing cost
R_c	- Relative cost coefficient
TR_c	- Total relative cost coefficient
C_l	- Labour rate
M_i	- Manufacturing cost
TM_i	- Total manufacturing cost
α	- Alpha rotational symmetry
β	- Beta rotational symmetry
mm	- Milimeter
s	- Second
%	- Percentage

N_{min} - Theoritical minimum number of components

N_{int} - Number of components in initial design

N_{red} - Number of components in redesign

t_i - Average assembly time per operation

n - Assembly operations

C_{mt} - Cost of the material per unit volume in the required form

mm^3 - Cubic milimeter

µm - Micrometer

W_c - Waste coefficient

N - Total production quantity per annum

T - Time for processing an ideal design of component

α - Cost of setting up and operating a specific process

β - A specific process total tooling for an ideal design

C_{mp} - Material process suitability

C_c - Component shape complexity

C_s - Component section coefficient

C_{ft} - Higher of C_t and C_f

C_t - Component tolerance coefficient

C_f - Component surface finish coefficient

Kg - Kilogram

N - Newton

m^3 - Cubic meter

m^2 - Square meter

N/m^2 - Pascal

Kg/m^3 - Mass density

HP - Horse power

Nm - Joule

M_{mc}	- Mass of chili
M_{cb}	- Mass of cutting blade
M_{ro}	- Mass of shaft rotator
M_{fb}	- Mass of fan blade
g	- Gravity of earth
$\mathrm{m/s^2}$	- Acceleration
F_{ult}	- Ultimate force
F_{apl}	- Applied force
P	- Power
T	- Torque
Pence	- A plural of penny, a coin or unit of currency
Cent	- A monetary unit that equals 1/100 of the basic monetary unit

LIST OF ABBREVIATION

DCSMM	- Dried Chili Seeds Separator Machine
DFMA	- Design for Manufacturing and Assembly
DFA	- Design for Assembly
DFM	- Design for manufacture
FOS	- Factor of Safety
PLC	- Product life cycle
CAD	- Computer aided design
AM	- Auto machining
CCEM	- Cold continuous extrusion (metals)
CDF	- Closed die forging
CEP	- Continuous extrusion (plastic)
CF	- Cold forming
CH	- Cold heading
CM2.5	- Chemical milling (2.5 mm depth)
CM5	- Chemical milling (5 mm depth)
CMC	- Ceramic mould casting
CNC	- Computer numerical controlled machining
CPM	- Compression moulding
GDC	- Gravity die casting
HCEM	- Hot continuous extrusion (metals)
IC	- Investment casting
IM	- Injection moulding
MM	- Manual machining
PDC	- Pressure die casting
PM	- Powder metallurgy

SM	- Shell moulding
SC	- Sand casting
SMW	- Sheet metal work
VF	- Vacuum forming
RS	- Rupee India or Sri lanka
RM	- Ringgit Malaysia
VON	- Von mises stress
ESTRN	- Equivalent strain

LIST OF APPENDIX

G3 Second design product drawing, exploded drawing, and BOM