

**IMPROVING QUALITY ON TIRE CURING PROCESS
BY USING SIX SIGMA AND FAILURE MODE AND EFFECTS ANALYSIS
(FMEA) METHOD IN INDONESIA LEADING TIRE MANUFACTURER**

By

Hartono
21952012

MASTER'S DEGREE
in

MASTER OF MECHANICAL ENGINEERING - ENGINEERING MANAGEMENT
FACULTY OF ENGINEERING AND INFORMATION TECHNOLOGY

The logo for Swiss German University (SGU) features the letters 'SGU' in a large, light blue, stylized font. A registered trademark symbol (®) is located to the right of the 'U'. Below this, the words 'SWISS GERMAN UNIVERSITY' are written in a smaller, dark blue, sans-serif font. The 'SGU' letters are also repeated in a dark grey color, overlapping the bottom of the 'SWISS GERMAN UNIVERSITY' text.

SWISS GERMAN UNIVERSITY

SWISS GERMAN UNIVERSITY
The Prominence Tower
Jalan Jalur Sutera Barat No. 15, Alam Sutera
Tangerang, Banten 15143 - Indonesia

February 2021

Revision after Thesis Defense on January 25, 2021

STATEMENT BY THE AUTHOR

I hereby declare that this submission is my own work and to the best of my knowledge, it contains no material previously published or written by another person, nor material which to a substantial extent has been accepted for the award of any other degree or diploma at any educational institution, except where due acknowledgement is made in the thesis.

[Hartono]

Student

Date

Revision after Thesis Defense on January 25, 2021

Approved by:

[Dr. Ir. Gembong Baskoro, M.Sc.]

Thesis Advisor

Date

[Dr. Eng. Sumarsono, S.T., M.T.]

Thesis Co-Advisor

Date

[Dr. Maulahikmah Galinium, S.Kom., M.Sc]

Dean

Date

Hartono

ABSTRACT

IMPROVING QUALITY ON TIRE CURING PROCESS BY USING SIX SIGMA AND FAILURE MODE AND EFFECTS ANALYSIS (FMEA) METHOD IN INDONESIA LEADING TIRE MANUFACTURER

By

Hartono

Dr. Ir. Gembong Baskoro, M.Sc., Advisor
Dr. Eng. Sumarsono, S.T., M.T., Co-Advisor

SWISS GERMAN UNIVERSITY

Tires are one component of transportation that has a very important role. Because the tires on the vehicle are direct contact with the road surface and affect safety. Truck Bus Bias Tire Manufacturer increased production during pandemic Covid-19. The tire production process requires production parameters according to specifications. Defect under cure is the highest defect during the period 2018-2020 (10.992 ppm). This research using the Six Sigma method and Failure Mode and Sffect Analysis. This method is a continuous improvement system that can be applied to solve a problem. Improvement will be made to the curing machine that contributes to the highest defect under cure and to machine components that have the highest risk priority number. Defect under cure was caused by deviation from one of the curing process specifications. Deviation was due to failure in the pneumatic system, namely no lubrication in pneumatic system (63.81%). Improvement made was the installation of an air lubricator on the curing machine. Improvement of the process using Six Sigma dan FMEA resulting in reduce defect under cure as from average 372 ppm to average 235 ppm. Preventive maintenance to maintain standard curing specifications on machine components that have the highest risk priority number.

Keywords: Six Sigma, FMEA, DMAIC, Tire, Defect.



SWISS GERMAN UNIVERSITY

DEDICATION

I dedicate this works for the future of the company I loved: Gajah Tunggal



ACKNOWLEDGEMENTS

Praise be to Allah SWT, because thanks to His grace and guidance, in the end the author can finish this thesis properly and on time. The author realizes that this thesis cannot be completed without guidance, support and assistance from various parties. With the completion of this thesis writing, allow the author to express his thanks to:

1. Parents and families who are never tired of giving prayers and motivation as long as the authors carry out the lecture process.
2. Dr. rer. nat. Filiana Santoso as Chancellor of the Swiss German University who has facilitated the implementation of the educational scholarship program.
3. Dr. Maulahikmah Galinium, S.Kom., M.Sc., as Dean of the Faculty of Engineering and Information Technology, Swiss German University.
4. Dr. Ir. Gembong Baskoro, M.Sc., as Director of Strategic Development and Cooperation, as Advisor who always provides motivation and education.
5. Dr. Eng. Sumarsono, S.T., M.T. as Co-Advisor who has taken the time, providing knowledge and motivation during the guidance period.
6. Dr. Ita Mariza as the Director of the Gajah Tunggal Polytechnic, who has guided and provided motivation during the lecture period.
7. All Swiss German University Lecturers and Staff who have helped smooth the lecture process.
8. Swiss German University student friends who always support and encourage each other from the beginning to the end of the lecture period.

TABLE OF CONTENTS

STATEMENT BY THE AUTHOR..... 2

ABSTRACT..... 3

DEDICATION 5

ACKNOWLEDGEMENTS 6

TABLE OF CONTENTS 7

LIST OF FIGURES 9

LIST OF TABLES 10

CHAPTER 1 - INTRODUCTION 11

1.1. Background 11

1.2. Research Problem 16

1.3. Research Objective 16

1.4. Research Question 16

1.5. Expected Result 16

1.6. Expexted Finding 16

1.7. Scope and Limitation 16

CHAPTER 2 - LITERATURE REVIEW 17

2.1. Quality..... 17

2.2. Curing Process 21

2.3. Six Sigma 24

2.4. Failure Mode and Effects Analysis (FMEA) 26

2.5. Break Even Point Analysis 31

2.6. Previous Study 31

CHAPTER 3 – RESEARCH METHODS 34

3.1. Scope of Study 34

3.2. Time Frame of Study 35

3.3. Research Framework 35

CHAPTER 4 – RESULTS AND DISCUSSIONS..... 38

4.1. Six Sigma-DMAIC 38

4.2. Failure Mode And Effect Analysis (FMEA) 43

4.3. Preventive Maintenance 55

4.4. Cost Analysis 58

CHAPTER 5 – CONCLUSIONS AND RECOMMENDATIONS 59

5.1. Conclusions..... 59

5.2. Recommendations..... 59

GLOSSARY 61

REFERENCES	62
CURRICULUM VITAE	65



LIST OF FIGURES

Figure 1. 1 Exported Value for Tyres Exported by Indonesia 11

Figure 1. 2 Quantity for Tyres Exported by Indonesia 11

Figure 1. 3 Tyres Production Truck Bus Bias Plant (Jan 2019 – Sep 2020) 12

Figure 1. 4 Data Defect 2018 13

Figure 1. 5 Data Defect 2019 14

Figure 1. 6 Data Defect 2020 (January – May)..... 14

Figure 1. 7 Defect Under Cure 14

Figure 1. 8 Average Key Performance Indicator Under Cure 15

Figure 1. 9 Key Performance Indicator Under Cure 15

Figure 2. 1 Check Sheet 18

Figure 2. 2 Flow Chart 18

Figure 2. 3 Histogram 19

Figure 2. 4 Scatter Diagram 19

Figure 2. 5 Control Chart 20

Figure 2. 6 Pareto Chart 21

Figure 2. 7 Fishbone Diagram..... 21

Figure 2. 8 Curing Process 22

Figure 2. 9 Tire Curing Machine 22

Figure 3. 1 Research Framework 36

Figure 4. 1 Average Key Performan Indicator Under Cure 38

Figure 4. 2 The Number Of Machines To Defect Under Cure 40

Figure 4. 3 The Cause Of Defect Under Cure 40

Figure 4. 4 Fishbone Diagram Defect Under Cure 41

Figure 4. 5 Air Lubricator 42

Figure 4. 6 Defect Under Cure After Improve 43

Figure 4. 7 IDEF0 (Integration Definition For Function Modeling) 44

Figure 4. 8 Data Defect Under Cure January 2018 – May 2020 45

Figure 4. 9 Fishbone Diagram Defect Under Cure 46

Figure 4. 10 Category Maintenance Strategy 51

Figure 4. 11 RPN Cause of Failure 52

Figure 4. 12 Modification Air Lubricator Pneumatic System 52

LIST OF TABLES

Table 2. 1 Maintenance Strategy Base On RPN	27
Table 2. 2 Saverity Rating	28
Table 2. 3 Occurance Rating.....	29
Table 2. 4 Detection Rating	30
Table 3. 1 Time Frame of Study	35
Table 4. 1 Defects Parts Per Million Six Sigma Chart.....	39
Table 4. 2 Failure Mode Defect Under Cure	44
Table 4. 3 Cause of Failure Defect Under Cure.....	47
Table 4. 4 Severity Rating Defect Under Cure	47
Table 4. 5 Occurance Rating Defect Under Cure	48
Table 4. 6 Current Control Defect Under Cure.....	48
Table 4. 7 Detection Rating Defect Under Cure.....	49
Table 4. 8 Risk Priority Number Defect Under Cure	50
Table 4. 9 FMEA Report for Defect Under Cure	54
Table 4. 10 Preventive Maintenance Center Mechanic Curing	55
Table 4. 11 Preventive Maintenance Curing Piping System	55
Table 4. 12 Preventive Maintenance Main Drive Curing	55
Table 4. 13 Preventive Maintenance Electric Equipment Curing.....	56
Table 4. 14 Bill of Quantity Improvement.....	58

SWISS GERMAN UNIVERSITY