

IMPROVING MEAN TIME BETWEEN FAILURE
OF HYDRAULIC EXCAVATOR KOMATSU PC4000-6 BY USING DMAIC

By

Deni Eko Mukti
22352027

Master of Mechanical Engineering
in

INDUSTRIAL ENGINEERING
FACULTY OF ENGINEERING INDUSTRIAL AND INFORMATION
TECHNOLOGY



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

Revision after Thesis Defence on 07 February 2025

STATEMENT BY THE AUTHOR

I hereby declare that this submission is entirely original with no content that has been published or written by another person, or that has been accepted for the award of any other degree or diploma at any educational institution, to the best of my knowledge, with the exception of those that are acknowledged in the thesis.

[Deni Eko Mukti]

Student

Date

Approved by:



[Assoc.Prof. Dr. Ir Gembong Baskoro M.Sc. IPU. ASEAN
Eng, APEC Eng]

Thesis Advisor

Date

[Prof. Dr.Ir. Sugiono, Ph.D]

Thesis Co-Advisor

Date

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

Dean

Date

ABSTRACT

IMPROVING MEAN TIME BETWEEN FAILURE OF HYDRAULIC EXCAVATOR KOMATSU PC4000-6 BY USING DMAIC

By

Deni Eko Mukti

Assoc.Prof. Dr. Ir Gembong Baskoro M.Sc. IPU. ASEAN Eng, APEC Eng

Prof. Dr.Ir. Sugiono, Ph.D

SWISS GERMAN UNIVERSITY

The maintenance process is very complex and involves the quality of the machine, this is supported by the process of looking at work methods, materials, machines and worker skills on hydraulic excavator machines. There is a need for a strategy to increase the efficient Mean Time Between Failure to be able to increase machine work productivity. The aim of this research is to formulate an appropriate strategy for producing Mean Time Between Failure values for hydraulic excavator machines. The step to increase the Mean Time Between Failure is by collecting data from the internal company PT United Tractors Tbk, which in the Full Maintenance Contract work contract with PT XYZ, the key performance indicator for Mean Time Between Failure is reached at 100 hours.

The problem that occurs is the Mean Time Between Failure performance on the Komatsu PC4000-6 Hydraulic Excavator is that the target is not achieved, namely it is achieved at 80 Hours or achieved only at 80%, and this achievement decreases by 20% of the target. According to the contract target, the Performance Mean Time Between Failure is 100 hours.

This research was carried out by taking the DMAIC approach, FMEA Risk Priority Number, 5W2H, Pareto Problem and Why - Why analysis. The research results of this study were that the Mean Time Between Failure was achieved according to the target of 100 hours or achieved 100%.

In conclusion, this research strategy is able to obtain the result performance of the Mean Time Between Failure of the Komatsu PC4000-6 Hydraulic Excavator which

can achieve the contract target, namely achieving Mean Time Between Failure of 80 hours (80%) to reaching Mean Time Between Failure of 100 hours (100%), and also this research can support the productivity of hydraulic excavator machines in mining operations according to customer expectations, and for the company PT United Tractors Tbk can maintain business service, namely the Full Maintenance Contract business for customers.



Keywords: Hydraulic Excavator Komatsu PC4000-6, DMAIC, FMEA, Why-Why analysis, Pareto, Priority risk (use scientific terms).

© Copyright 2025
by Deni Eko Mukti
All rights reserved



DEDICATION

This thesis is my present to my parents, who have patiently raised me, taught me life's sciences, and still love me unconditionally.

This thesis is a unique gift for my wife, whom I adore. I appreciate all your help, generosity, concern, and insight. I appreciate you teaching me how to lead a moral and contented life.

This thesis is dedicated in particularly to my kids, who have given up playing with me due to job and college obligations.



ACKNOWLEDGEMENTS

By His grace, Alhamdulillah, the author is able complete this thesis on schedule, thank God. Without the assistance and backing of numerous people, this thesis cannot be finished. The author would like to sincerely thank everyone who helped with the writing of this thesis, including:

1. Abu Lasiran and Sri Utami as the author's father and mother who always support and wish their children the success.
2. Sumiati, Alya Mukti Az-Zahra, Luthfiyyah Mukti Aulia, Syahira Mukti Khairunnisa, as my family who always support to the author.
3. Mr. Edhie Sarwono, Mr. Idot Supriadi, Mr. Abun Jufar Jaya, Mr. Rudy Poerwanto, Mr Jonihardi, and Mr. Heri Priyo Mahargyo, who has given me the opportunity and support during my master's education.
4. Assoc.Prof. Dr. Ir Gembong Baskoro M.Sc. IPU. ASEAN Eng, APEC Eng, as SGU's SDC Director and as Advisor who always provides motivation and education.
5. Prof. Dr.Ir. Sugiono, Ph.D, as Co-Advisor who always gave directions and corrections in writing the thesis.
6. Dr. Ir. Maulahikmah Galinium, S.Kom. M.Sc, as Dean of the Faculty of Engineering and Information Technology at Swiss German University who has streamlined the thesis writing process.
7. 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

	Page
STATEMENT BY THE AUTHOR.....	2
ABSTRACT.....	3
DEDICATION.....	6
ACKNOWLEDGEMENTS.....	7
TABLE OF CONTENTS.....	8
LIST OF FIGURES	10
LIST OF TABLES.....	12
CHAPTER 1 - INTRODUCTION.....	13
1.1 Background.....	13
1.2 Research Problem.....	18
1.3 Research Objectives.....	20
1.4 Research Questions.....	20
1.5 Hypothesis.....	20
CHAPTER 2 - LITERATURE REVIEW	21
2.1 Theoretical Perspective.....	21
2.1.1 Preventive Maintenance.....	22
2.1.2 DMAIC Platform.....	22
2.1.3 Failure Methode & Effect Analysis (FMEA).....	22
2.1.4 Manpower Development Program.....	23
2.1.5 Maintenance electrical system.....	24
2.1.6 Fishbone Diagram.....	25
2.2 Previous Studies.....	26
CHAPTER 3 – RESEARCH METHODS	27
3.1 Materials and Equipment	27
3.2 Analytical Method	28
3.2.1 Define Phase.....	28
3.2.2 Measure Phase.....	31
3.2.3 Analize Phase.....	32
3.2.4 Improve Phase.....	33
3.2.5 Control Phase.....	34
3.3 Time Frame Project.....	36
CHAPTER 4 – RESULTS AND DISCUSSIONS.....	37
4.1 Define.....	37
4.1.1 Overview of PT United Tractors Tbk Full Maintenance Contract of Hydraulic Excavator Komatsu PC4000-6 PT XYZ Job site Adaro Indonesia.....	37
4.1.2 Full Maintenance Contract of Hydraulic Excavator Komatsu PC4000-6 Mean Time Between Failure Availability.....	39
4.1.3 Daily Breakdown record machine of Full Maintenance Contract.....	40

4.2 Measure.....	43
4.3 Analyse.....	49
4.3.1 Why-Why Analysis.....	50
4.3.2 FMEA Analysis.....	51
4.3.3 5W2H Analysis.....	56
4.4 Improvement Process.....	59
4.4.1 Implementation Improvement of Element Factor MAN.....	60
4.4.2 Implementation Improvement of Element Factor METHODE.....	62
4.4.3 Implementation Improvement of Element Factor MACHINE.....	64
4.4.4 Implementation Improvement of Element Factor MATERIAL.....	67
4.4.5 Effectiveness of Improvement.....	70
4.5 Control.....	76
4.5.1 New Check Sheet Periodical Service.....	77
4.5.2 New Check Sheet Periodical Inspection Electrical system.....	79
4.5.3 New Standardization or Memorandum Mandatory Periodical Inspection electrical system.....	81
4.6 Discussion.....	84
4.6.1 Review Pareto problem.....	84
4.6.2 Review Mechanic upgrade competency.....	86
4.6.3 Review Performance Mean Time Between Failure.....	88
CHAPTER 5 – CONCLUSION AND RECCOMENDATIONS	89
5.1 Conclusion.....	89
5.2 Recommendations	90
5.2.1 For the Company.....	90
5.2.2 For further research.....	91
GLOSSARY	92
REFERENCES	93
CURRICULUM VITAE.....	96

LIST OF FIGURES

Figures	Page
Figure 1.1 United Tractors member of Astra.....	14
Figure 1.2 Logo of AHEMCE Group.....	14
Figure 1.3 AHEMCE Group Business Company.....	15
Figure 1.4 Slogan of United Tractors is Moving as one.....	15
Figure 1.5 Detail location of project.....	16
Figure 1.6 Mining Working methods Details.....	16
Figure 1.7 Hydraulic Excavator Komatsu PC4000-6 Operating Position in Coal Mining Business.....	17
Figure 1.8 Contract & Rental Service Business of PT United Tractors Tbk.....	17
Figure 1.9 Pareto problem data hydraulic excavator Komatsu PC4000-6.....	18
Figure 1.10 Pareto Problem of Hydraulic Excavator Komatsu PC4000-6.....	19
Figure 2.1 Fishbone Methode (Tamer M. EI-Dogdog.2016).....	25
Figure 3.1 DMAIC flow charts.....	28
Figure 3.2 Define phase flow Process.....	29
Figure 3.3 Measure phase flow Process.....	30
Figure 3.4 Analyze phase flow Process.....	32
Figure 3.5 Improve phase flow Process.....	33
Figure 3.6 Control phase flow Process.....	35
Figure 4.1 Flow Process of Maintenance Strategy in FMC Komatsu PC4000-6.....	38
Figure 4.2 Komatsu PC4000-6 Mean Time Between Failure performance Availability, 2023.....	39
Figure 4.3 Mapping of Flow Downtime that affects Availability.....	40
Figure 4.4 Mean Time Between Failure data record Jul – Dec 2023 Full Maintenance Contract of Komatsu PC4000-6.....	43
Figure 4.5 Pareto Problem diagram as <i>frequency by component of unscheduled breakdown (BUS)</i>	44
Figure 4.6 Pareto problem diagram as <i>frequency by sub component electrical of unscheduled breakdown (BUS)</i>	44
Figure 4.7 Pareto problem <i>Frequency unscheduled maintenance</i> monthly by component.....	45
Figure 4.8 Measurement of Mechanic Quantity & Competency.....	45

Figure 4.9 Mechanic Grading and experience.....	46
Figure 4.10 Training and competency of 11 persons junior mechanics.....	47
Figure 4.11 Measurement of Periodic Inspection Achievement.....	48
Figure 4.12 Measurement of Periodic Service Performance.....	48
Figure 4.13 Fishbone diagram problem solving analysis.....	58
Figure 4.14 Activity project Training and mentoring, Assistance of junior mechanic	61
Figure 4.15 Achievement of training electrical system 11 persons junior mechanic.....	62
Figure 4.16 Activity of Group Discussion to appointing the teams electrical.....	63
Figure 4.17 New Structure organization of teams Full Maintenance Contract PC4000-6.....	64
Figure 4.18 Sheet monitoring of Electrical check.....	65
Figure 4.19 Electrical Measurement with periodically schedule measurement.....	66
Figure 4.20 File Monitoring measurement electric, File save at One Drive.....	66
Figure 4.21 Activity Discussion of preventive activity at relay.....	67
Figure 4.22 Component electric at X2 room Komatsu PC4000-6.....	68
Figure 4.23 Activity preventive problem and Factfinding problem at the relay.....	69
Figure 4.24 Schedule inspection electrical and repair of relay.....	69
Figure 4.25 Mean Time Between Failure after Improvement.....	73
Figure 4.26 Pareto of problem unscheduled component by frequency after improvement	75
Figure 4.27 Frequency unscheduled breakdown by month after improvement.....	75
Figure 4.28 Activity Focus Group Discussion Team PC4000-6.....	76
Figure 4.29 New Check sheet Periodical Service Maintenance PC4000-6.....	78
Figure 4.30 Memorandum mandatory of Inspection electrical system every 500 hours.....	83
Figure 4.31 Pareto Problem result improvement Komatsu PC4000-6 by month.....	84
Figure 4.32 Pareto problem electric result improvement Komatsu PC4000-6 before and after	85
Figure 4.33. Frequency & Leadtime result improvement Komatsu PC4000-6 before and after.....	85

Figure 4.34 Upgrade Mechanic junior competency result improvement.....87

Figure 4.35 Mean Time Between Failure result improvement Komatsu PC4000-6 ...88

LIST OF TABLES

Table	Page
Table 2.1 Previous Study of Research.....	26
Table 3.1 Timeframe of Project.....	35
Table 4.1 Raw of Data Daily Breakdown Record FMC PC4000-6.....	41
Table 4.2 Why-Why Analysis data problem hydraulic excavator.....	50
Table 4.3 Severity Value Criteria Level to Calculate FMEA.....	53
Table 4.4 Occurrence of Value Criteria Level to Calculate FMEA.....	54
Table 4.5 Detection of Value Criteria Level to Calculate FMEA.....	54
Table 4.6 Risk Priority Number Calculation Results problem component electric.....	55
Table 4.7 5W2H analysis problem detection component electric.....	57
Table 4.8 4 Element Factor and root cause dominant determined.....	58
Table 4.9 Solution taken of project improvements	59
Table 4.10 Achievement of Implementation training mechanic every week.....	61
Table 4. 11 Daily record of maintenance PC4000-6 after improvement.....	70
Table 4.12 Electrical problem RPN point after project implementation.....	72
Table 4.13 Tabel of <i>Summary MTBF</i> PC4000-6 after improvement.....	73
Table 4.14 Standardization in project electrical system.....	76
Table 4.15 New Check sheet Periodical inspection electrical system.....	80
Table 4.16 Mechanic competency by point post test result improvement.....	86