1. *Operations Research & Analysis*
2. *Quality & Reliability Engineering*

DESIGNING FLEET MANAGEMENT SYSTEM TO INCREASE THE PRODUCTION ACHIEVEMENT AT COAL MINING CONTRACTOR

FINAL PROJECT

Submitted in Partial Fulfillment of the Requirement for the Degree of Bachelor of Engineering in Industrial Engineering

Sindi Artania	**221411597**
Gabriella Amanda Ayu Narasitha	**221411860**
Christoforus Ariffianto Roesmarjati	**221412049**

INTERNATIONAL INDUSTRIAL ENGINEERING
DEPARTMENT OF INDUSTRIAL ENGINEERING
FACULTY OF INDUSTRIAL TECHNOLOGY
UNIVERSITAS ATMA JAYA YOGYAKARTA
YOGYAKARTA

2026

IDENTITY PAGE

Final Project's Title:

Designing Fleet Management System to Increase the Production Achievement at Coal Mining Contractor

IE Body of Knowledge:

1. *Operations Research & Analysis*
2. *Quality & Reliability Engineering*

Final Project's Team:

No.	Name & Student Num	Study Program	University	Role Description in Design
1	Sindi Artania 221411597	Teknik Industri Internasional	UAJY	• Designs the fleet allocation model that adjusts production targets using rainfall forecasting to reduce weather-related loss time. • Prepares/cleans required data, runs scenario/sensitivity analysis, and writes the fleet-allocation methodology and results section.
2	Gabriella Amanda Ayu Narasitha 221411860	Teknik Industri Internasional	UAJY	• Designs a data-driven inventory control policy (e.g., prioritization, reorder rules, safety stock) to reduce downtime caused by part unavailability. • Build the inventory/usage dataset, evaluates policy performance, and writes the spare-part system methodology and results section.
3	Christoforus Ariffianto Roesmarjati 221412049	Teknik Industri Internasional	UAJY	• Designs a preventive maintenance scheduling model using historical data to reduce unplanned downtime and improve fleet availability. • Builds the maintenance/hour-meter dataset, validates the schedule with analysis/scenarios, and writes the PM methodology and results section.

HALAMAN PENGESAHAN

Tugas Akhir Berjudul

DESIGNING FLEET MANAGEMENT SYSTEM TO INCREASE THE PRODUCTION ACHIEVEMENT AT COAL MINING CONTRACTOR

yang disusun oleh

Christoforus Ariffianto Roesmarjati

221412049

dinyatakan telah memenuhi syarat pada tanggal 13 Juli 2026

		Keterangan
Dosen Pembimbing 1	: Dr. Ir. Yosephine Suharyanti, S.T., M.T.	Telah Menyetujui
Dosen Pembimbing 2	: L. Bening Parwita Sukci, S.Pd., M.Hum.	Telah Menyetujui
Tim Penguji		
Penguji 1	: Dr. Ir. Yosephine Suharyanti, S.T., M.T.	Telah Menyetujui
Penguji 2	: Dr. Slamet Setio Wigati, S.T., M.T.	Telah Menyetujui
Penguji 3	: Prof. Ir. The Jin Ai, S.T., M.T., D.Eng.	Telah Menyetujui

Yogyakarta, 13 Juli 2026

Universitas Atma Jaya Yogyakarta

Teknologi Industri

Dekan

ttd.

Prof. Dr. Ir. Parama Kartika Dewa SP., S.T., M.T., IPU, ASEAN Eng.

Dokumen ini merupakan dokumen resmi UAJY yang tidak memerlukan tanda tangan karena dihasilkan secara elektronik oleh Sistem Bimbingan UAJY. UAJY bertanggung jawab penuh atas informasi yang tertera di dalam dokumen ini

ORIGINALITY STATEMENT

We are the undersigned:

1. Name : Sindi Artania
   Student ID : 221411597
2. Name : Gabriella Amanda Ayu Narasitha
   Student ID : 221411860
3. Name: Christoforus Ariffianto Roesmarjati

   Student ID : 221412049

We hereby declare that we with the title " Designing Fleet Management System to Increase the Production Achievement at Coal Mining Contractor" is our work in 2025-2026 which is original and does not contain plagiarism of any work.

If the work was later found to be inconsistent with this statement, so we are willing to be prosecuted and processed in accordance with applicable regulations.

Thus, we make this statement truly and truly.

TABLE OF CONTENTS

TITLE PAGE i
IDENTITY PAGE ii
APPROVAL PAGE iii
ORIGINALITY STATEMENT iv
TABLE OF CONTENTS v
LIST OF FIGURES 6
PREFACE 8
ABSTRACT 10
CHAPTER 1 INTRODUCTION 11
1.1 Research Background 11
1.2 Problem Exploration 12
1.3 Problem Statement 19
1.4 Objective 19
1.5 Scope and Limitation 19
CHAPTER 2 LITERATURE REVIEW AND THEORETICAL BACKGROUND 21
2.1 Literature Review 21
2.2 Theoretical Background 30
2.3 Standards and Codes of Ethics 35
CHAPTER 3 ROOT CAUSE IDENTIFICATION AND GENERATING SOLUTIONS 37
3.1 Overview of the System 37
3.2 Root Cause Identification 38
3.3 Generating and Determining Alternative Solutions 42
3.4 Teamwork Planning for Solution Design 50
3.5 Selection of Methods and Tools 57
CHAPTER 4 FINAL PROJECT METHODOLOGY 65
4.1 Final Project Stages 65
4.2 Empathizing Stages 66
4.3 Defining Stage 67
4.4 Ideating Stage 68
4.5 Prototyping Stage and Designing Methodology 69
4.6 Testing Stage 73
4.7 Final Project Uniqueness 77
4.8 Final Project Schedule Plan 77
CHAPTER 5 DESIGN MAINTENANCE SCHEDULING SYSTEM 80
5.1 Confirming Objectives and Key Performance Indicators 80
5.2 Reliability and Breakdown Analysis 87
5.3 Preventive Maintenance Evaluation 90

5.4 Proposed Maintenance Improvement 91
CHAPTER 6 DESIGN A DATA-DRIVEN INVENTORY CONTROL SYSTEM 109
6.1 Downtime Identification 109
6.2 Failure Identification 114
6.3 Failure Frequency Analysis 151
6.4 Inventory Parameter Determination 154
6.5 Proposed Multi-Item Inventory Ordering Policy 165
6.6 Standard Operating Procedure (SOP) for Spare Part Inventory Control 165
6.7 Inventory System Simulation 171
CHAPTER 7 FLEET MANAGEMENT SYSTEM 188
7.1 Rain Forecasting 188
7.2 Loss Time Calculation 195
7.3 Production Scheduling 197
7.4 Determination of Fleet Capacity 207
7.5 System Evaluation 210
CHAPTER 8 CSF ACHIEVEMENT 230
8.1 Team Member’s Achievement Analysis 230
8.2 Critical Success Factor (CSF) Validation and Evaluation 237
CHAPTER 9 CONCLUSION AND RECOMMENDATIONS 241
9.1 Conclusion 241
9.2 Recommendations 242
REFERENCES 245
LIST OF APPENDIXES 249

LIST OF TABLES

Table 1.1 Physical availability achievement in August 2025 14
Table 1.2 MTBF 2025 in hours 14
Table 1.3 Summary of loss time in 2023 16
Table 1.4 Summary of loss time in 2024 16
Table 1.5 Problem observation summary 18
Table 1.6 Problem summary 19
Table 2.1 Summary of Literature Review 27
Table 3.1 Method selection 46
Table 3.2 Selection of alternative solutions 47
Table 3.3 Methods to design a data-driven inventory control system 58
Table 3.4 Methods to design maintenance scheduling system 60
Table 3.5 Methods to design fleet system management 62
Table 5.1 Unit list in maintenance department 83
Table 5.2 All intersected unit 84
Table 5.3 BCM target allocation 97
Table 5.4 Reliability target based on regression 97
Table 5.5 λ Average across model 98
Table 5.6 New PM interval 100
Table 5.7 Adjusted new PM interval 101
Table 6.1 Fleet Inventory and Quantity 114
Table 6.2 Periodical service range and activity HD 785-7 116
Table 6.3 High risk damage that can occur on PS 1-4 119
Table 6.4 Medium risk damage that can occur on PS 1-4 120
Table 6.5 Low risk damage that can occur on PS 1-4 120
Table 6.6 Periodical service 1 details for HD 785-7 123
Table 6.7 Periodical service 2 details for HD 785-7 124
Table 6.8 Periodical service 3 details for HD 785-7 125
Table 6.9 Periodical service 4 details for HD 785-7 126
Table 6.10 Periodical service range and activity 777E 128
Table 6.11 High risk damage that can occur on PS 1-4 129
Table 6.12 Medium risk damage that can occur on PS 1-4 130
Table 6.13 Low risk damage that can occur on PS 1-4 131
Table 6.14 Periodical service 1 details for 777E 133
Table 6.15 Periodical service 2 details for 777E 134
Table 6.16 Periodical service 3 details for 777E 135
Table 6.17 Periodical service 4 details for 777E 136

Table 6.18 Periodical service range and activity 777 138
Table 6.19 High risk damage that can occur on PS 1-4 141
Table 6.20 Medium risk damage that can occur on PS 1-4 142
Table 6.21 Low risk damage that can occur on PS 1-4 143
Table 6.22 Periodical service 1 details for 777 145
Table 6.23 Periodical service 2 details for 777 146
Table 6.24 Periodical service 3 details for 777 147
Table 6.25 Periodical service 4 details for 777 149
Table 6.26 HD 785-7 fleet damage on each date (October 2025) 151
Table 6.27 HD 777E fleet damage on each date (October 2025) 152
Table 6.28 HD 777 fleet damage on each date (October 2025) 153
Table 6.29 Inventory Parameter Results for HD 785-7 Spare Parts 160
Table 6.30 Inventory Parameter Results for 777E Spare Parts 162
Table 6.31 Inventory Parameter Results for 777 Spare Parts 164
Table 6.32 Operational Assumptions 171
Table 6.33 Average demand and standard deviation 174
Table 6.34 Skewness Analysis Summary Result 175
Table 6.35 Fleet’s Cluster Summary 176
Table 6.36 MTTR Reduction 181
Table 7.1 Loss time in 2023 189
Table 7.2 Loss time in 2024 190
Table 7.3 Loss time in 2025 191
Table 7.4 Rainfall history 2017-2023 192
Table 7.5 Average rain per season 193
Table 7.6 Forecast from 2024-2026 195
Table 7.7 EWH data in 2023 196
Table 7.8 EWH data in 2024 196
Table 7.9 Overburden production achievement 198
Table 7.10 Coal production achievement 199
Table 7.11 Regression calculation for OB 202
Table 7.12 Regression calculation for coal 202
Table 7.13 Slope and intercept results 203
Table 7.14 Result of EWH estimation & production plan OB 203
Table 7.15 Result of EWH estimation & production plan coal 205
Table 7.16 Production plan adjusted by EWH plan for OB 206
Table 7.17 Production plan adjusted by EWH plan for coal 206
Table 7.18 Loader unit 207

Table 7.19 Hauler unit 207
Table 7.20 Loader capacity 208
Table 7.21 Hauler capacity 208
Table 7.22 Loader rental cost 209
Table 7.23 Hauler rental cost 209
Table 7.24 Parameters 211
Table 7.25 Decision variables 212
Table 7.26 Solver template 214
Table 7.27 Solver result 215
Table 7.28 Output template 216
Table 7.29 Output results 216
Table 7.30 Available BCM/hour comparison for loader 217
Table 7.31 Available BCM/hour comparison for hauler 217
Table 7.32 Production achievements before fleet adjustments for loader 218
Table 7.33 Production achievements after fleet adjustments for loader 219
Table 7.34 Production achievements before fleet adjustments for hauler 220
Table 7.35 Production achievements after fleet adjustments for hauler 221
Table 7.36 Simulation Target 226
Table 7.37 Simulation data for OB 226
Table 7.38 Simulation data for coal 227
Table 7.39 Capacity simulation summary 227
Table 7.40 Solver simulation 227
Table 7.41 Solver simulation result 227
Table 8.1 Simulation Steady State Result 230
Table 8.2 Fleet-Level volumetric production surplus and contribution matrix 231
Table 8.3 12-Month macro site production target achievement comparison (pm old vs. pm new) 232
Table 8.4 Estimated operational improvement after implementing proposed inventory system 232
Table 8.5 Percentage Improvement 234
Table 8.6 Improvement from maintenance scheduling and inventory control 235
Table 8.7 Results comparison before rental decision 236
Table 8.8 Results comparison after rental decision 236
Table 8.9 Rental decision comparison 236
Table 8.10 Achievement comparison for loader 237
Table 8.11 Production achievements before fleet adjustments and after integration for hauler 238
Table 8.12 Production achievements after fleet adjustments and after integration for hauler 238

Table 8.13 Achievement comparison for hauler 239

LIST OF FIGURES

Figure 1.1 Organizational structure 12
Figure 1.2 Dashboard in PKPP 13
Figure 1.3 Maintenance workshop 14
Figure 1.4 Loss time August 2025 15
Figure 1.5 Production Loss Chart 17
Figure 3.1 Fishbone diagram 39
Figure 3.2. Interrelationship diagram 41
Figure 3.3 Overall design framework 50
Figure 3.4 Flowchart of maintenance scheduling system 52
Figure 3.5 Flowchart of data-driven inventory control system 54
Figure 3.6 Flowchart of fleet allocation system 56
Figure 4.1 Overall framework 65
Figure 4.2 Flow of activities in the empathizing stage 67
Figure 4.3 Flow of activities in defining phase 68
Figure 4.4 Flow of activities in ideation phase 69
Figure 4.5 Flowchart prototyping stage of data-driven inventory control system 70
Figure 4.6 Flowchart prototyping stage of PM scheduling system 71
Figure 4.7 Flowchart prototyping stage of fleet allocation system 72
Figure 4.8 Testing stage of Flowchart prototyping stage of data-driven inventory control system 74
Figure 4.9 Testing stage of fleet allocation system design 75
Figure 4.10 Testing stage of PM scheduling system design 76
Figure 4.11 Final project schedule plan 79
Figure 5.1 Venn diagram for dataset intersection 86
Figure 5.2 Probability Plot 89
Figure 5.3 Regression HD 785-7 Rel vs BCM/day 93
Figure 5.4 Regression PC1250SP-8R Rel vs BCM/day 93
Figure 5.5 Regression 777 Rel vs BCM/day 94
Figure 5.6 Regression 777E Green Rel vs BCM/day 94
Figure 5.7 Regression 777E Yellow Rel vs BCM/day 95
Figure 5.8 Degradation Behaviour HD 785-7 103
Figure 5.9 Degradation Behaviour PC1250SP-8R 103
Figure 5.10 Degradation Behaviour 777 104
Figure 5.11 Degradation Behaviour 777E 104
Figure 5.12 Simulation Tabel of Fleet Model HD 785-7 107
Figure 6.1 Overburden average variance relative to *RKAP* (2023-2025) pareto chart 110

Figure 6.2 Overburden average percentage contribution to total lost time (2023-2025) pareto chart 111
Figure 6.3 Coal average variance relative to *RKAP* (2023-2025) pareto chart 112
Figure 6.4 Coal average percentage contribution to total lost time (2023–2025) pareto chart 113
Figure 6.5 Pareto Diagram of Fleet Type as a Basis for Determining Priorities 114
Figure 6.6 Steady State Diagram – 777E 178
Figure 6.7 Steady State Diagram – HD785 178
Figure 6.8 Steady State Diagram – 777E 179
Figure 6.9 Simulation Sample 179
Figure 6.10 777E Average Service Level 184
Figure 6.11 HD785 Average Service Level 184
Figure 6.12 777 Average Service Level 184
Figure 6.13 New 777E Average Service Level 186
Figure 6.14 New HD 785-7 Average Service Level 186
Figure 6.15 New 777 Average Service Level 187
Figure 7.1 Rain and slippery graph in 2023. 189
Figure 7.2 Rain and slippery graph in 2024 190
Figure 7.3 Rain and slippery graph in 2025 191
Figure 7.4 Rainfall from 2017-2023 in Muara Enim 193
Figure 7.5 OB production target 200
Figure 7.6 Coal production target 200
Figure 7.7 Prepare input data 224
Figure 7.8 Solver sheet 224
Figure 7.9 Find solver 225
Figure 7.10 Solver parameters 225
Figure 7.11 Solver result 226

PREFACE

The authors would like to express their deepest gratitude to God Almighty for His grace, guidance, and blessings, which have enabled the completion of this final project proposal. This proposal, entitled “Designing Fleet Management System to Increase Effective Working Hours at Coal Mining Contractor” is prepared as a requirement for completing the Bachelor Program in Industrial Engineering, Department of Industrial Engineering, Faculty of Industrial Technology (FTI), Atma Jaya Yogyakarta University (UAJY). Its preparation marks the initial stage of the final project research, which is expected to contribute to the development of industrial engineering knowledge and its practical application in the industrial sector.

The completion of this proposal would not have been possible without the support, encouragement, and assistance of many parties. Therefore, the authors sincerely extend their appreciation and gratitude to:

1. Dr. Ir. Parama Kartika Dewa SP., S.T., M.T., IPU, ASEAN Eng., Dean of the Faculty of Industrial Technology, Atma Jaya Yogyakarta University.
2. Dr. Ir. Drs. Ignatius Luddy Indra Purnama, M.Sc., IPU, Head of the Department of Industrial Engineering, Atma Jaya Yogyakarta University.
3. Ir. Twin Yoshua R. Destyanto, S.T., M.Sc., Ph.D., IPM, Head of the Bachelor Program in Industrial Engineering, Atma Jaya Yogyakarta University.
4. Dr. Ir. Yosephine Suharyanti, S.T., M.T., IPU, Ir. Yosef Daryanto, S.T., M.Sc., Ph.D., and Dra. L. Bening Parwita Sukci, M.Hum., the supervisors who have generously provided guidance, feedback, and valuable insights throughout the preparation of this proposal.
5. Mr. Irvan, Mr. Bagus, Ms. Feni, and the entire staff of the company, for their assistance, support, and access to data essential for the research.
6. The authors’ parents, for their unwavering prayers, encouragement, and continuous support during the study period and throughout the preparation of this proposal.
7. All individuals who cannot be mentioned one by one, yet have contributed their support, help, and motivation in various forms during the preparation of this proposal.

The authors recognize that this proposal is not without shortcomings. Nevertheless, it is our sincere hope that this work may serve as a useful foundation for the final project research and provide positive contributions to both academic development and industrial practice.

Yogyakarta, 12 December 2025

Sindi Artania | 221411597
Gabriella Amanda Ayu Narasitha | 221411860
Christoforus Ariffianto Roesmarjati | 221412049

ABSTRACT

Fleet productivity plays a major role in determining the success of mining operations, as it directly affects production achievement, operational efficiency, and overall cost. PT XX is a mining contractor responsible for overburden removal operations using heavy equipment fleets. The company experienced production shortfalls due to insufficient fleet capacity, unplanned equipment downtime caused by ineffective spare part inventory management, and productivity losses resulting from unpredictable rainfall. These problems indicated that fleet management activities were not integrated, limiting effective production planning and decision-making.

This project proposes an integrated fleet management system consisting of three components. A maintenance scheduling system models equipment degradation using historical data to determine optimal preventive maintenance intervals based on Reliability Centered Maintenance model and to improve equipment availability. An inventory control system applies the Economic Order Quantity (EOQ) and Reorder Point (ROP) methods with safety stock to optimize spare part replenishment while maintaining a minimum service level of 95%. A fleet optimization system determines the optimal rental fleet composition using Integer Linear Programming to satisfy production requirements at minimum rental cost, supported by rainfall forecasting using the seasonal average method to estimate effective working hours.

The proposed system improves production planning and operational decision-making by integrating maintenance, inventory, and fleet planning. The optimization model identifies the minimum-cost rental fleet composition required to achieve production targets, while the inventory model maintains the targeted 95% service level and reduces downtime caused by spare part shortages. Rainfall forecasting further supports more realistic production scheduling, contributing to improved fleet productivity, equipment availability, and operational efficiency.

Keywords: Mining Operations, Maintenance Scheduling, Inventory Control, Fleet Management System, Reliability Centered Maintenance, Economic Order Quantity, Linear Programming.