

CHAPTER 3 - RESEARCH METHODS

3.1 Research Methods

To solve the problem in this study and for this research to be a good research, so appropriate and appropriate methods must be needed. In Chapter 3, the author uses the DMAIC method (Define, Measure, Analyze, Improve, Control). The DMAIC method is one of Six Sigma's most frequently used methods to address problems of failure or failure, deviation from targets, cost or time overruns, and quality degradation.

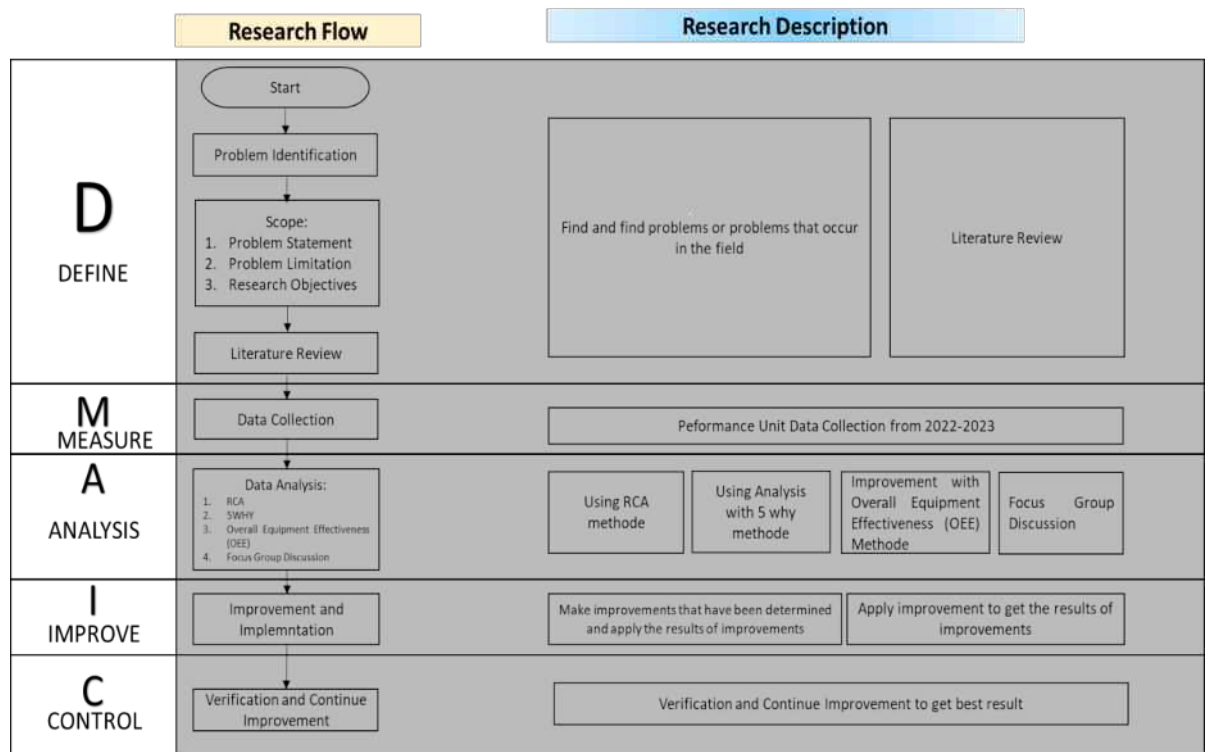


Figure 3.1 Research Flow

3.2 Analytical Method

3.2.1 Define

3.2.1.1 Literature Review

In this chapter of literature, the author is looking for literature to use as a source when conducting research.

3.2.1.2 Scope

In the scope discussion, describe several things, namely:

1. The goal of a masalah rumor is to identify and describe any issues or problems that are currently occurring in the area in order to turn it into a study.
2. The limitations of the problem are the limits taken by the author so that the discussion of this research does not widen. The limitation of the problem taken by the author is the performance unit Scania P360/P410.
3. Research Objectives are goals expected by the author to be able to find solutions from research.

3.3 Measure

3.3.1 Data Collection

Data collection is a stage to find data before analyzing. At this stage the author uses several methods to collect data, including:

3.3.1.1 Customer Relation Chart (CRC)

From the problems related to production achievements and physical availability of the P360/P410 units described above, PT. ABC has 3 determination to meet the target of PT. XYZ.

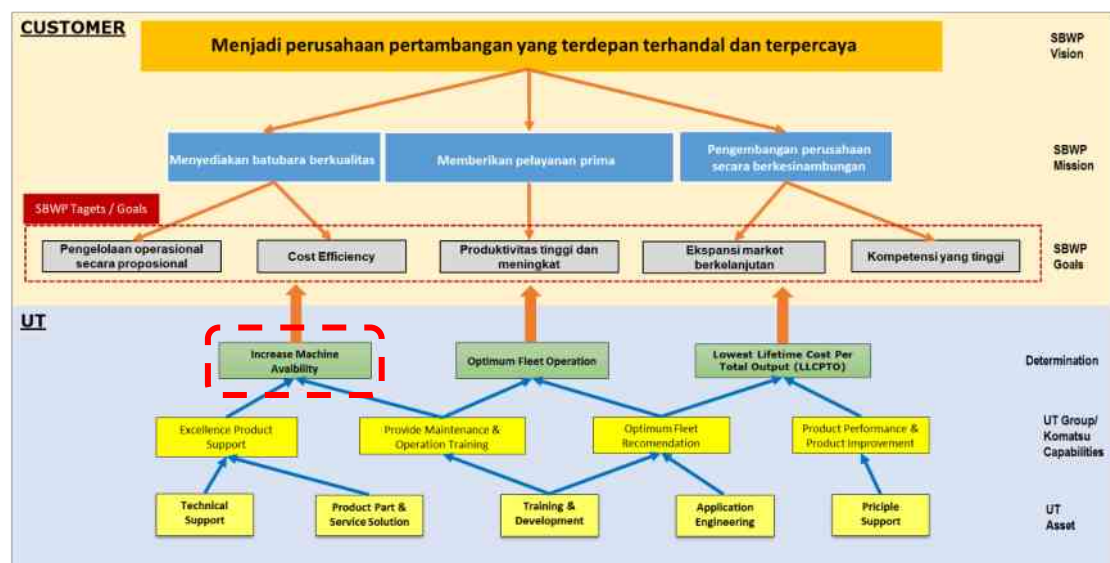


Figure 3.2 Customer Relation Chart (CRC) PT. ABC - PT. XYZ

The 3 determinations are:

1. Increase Machine Availability
2. Optimum Fleet Operation
3. Lowest Lifetime Cost per Total Output (LLCPTO)

The focus of this research is on increasing Machine Availability because units that have high Machine Availability are the main factors to increase production.

3.3.1.2 Physical Availability (PA)

Data taken at PT. XYZ, it was found that the Physical Availability (PA) data on January 23 – June 23, 2023 obtained the following results:

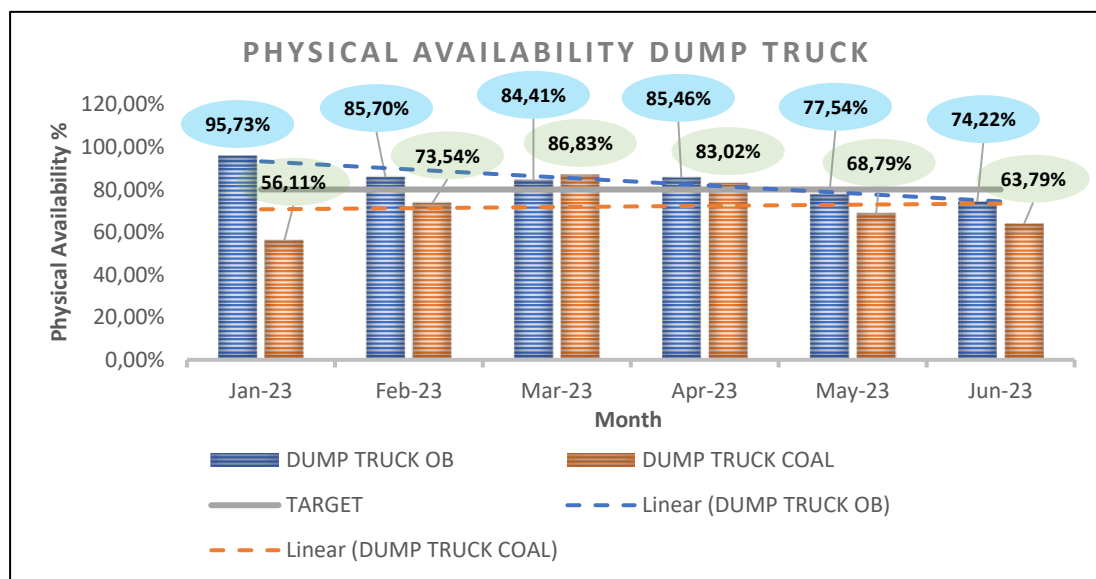


Figure 3.3 Grafic Physical Availability (PA)

Table 3.1 Physical Availability Unit Dump Truck OB

No	Category	Month	Available Hours	Working Hours	Breakdown Hours	Stanby Hours	Physical Availability (PA)
1	DUMP TRUCK OB	Jan-23	16.368	4.226	699	11.443	95,73%
2	DUMP TRUCK OB	Feb-23	14.784	3.495	2.114	9.175	85,70%
3	DUMP TRUCK OB	Mar-23	16.368	4.258	2.551	9.559	84,41%
4	DUMP TRUCK OB	Apr-23	15.840	5.296	2.303	8.240	85,46%
5	DUMP TRUCK OB	May-23	16.368	7.144	3.676	5.548	77,54%
6	DUMP TRUCK OB	Jun-23	15.840	7.464	4.083	4.293	74,22%
TOTAL			95.568	31.883	15.426	48.259	83,86%

Table 3.2 Physical Availability Unit Coal Dump Truck

No	Category	Month	Available Hours	Working Hours	Breakdown Hours	Standby Hours	Physical Availability (PA)
1	DUMP TRUCK COAL	Jan-23	5.952	1.178	2.613	2.161	56,11%
2	DUMP TRUCK COAL	Feb-23	5.376	1.412	1.422	2.542	73,54%
3	DUMP TRUCK COAL	Mar-23	5.952	1.963	784	3.205	86,83%
4	DUMP TRUCK COAL	Apr-23	5.760	2.146	978	2.636	83,02%
5	DUMP TRUCK COAL	May-23	5.952	2.276	1.858	1.818	68,79%
6	DUMP TRUCK COAL	Jun-23	5.760	2.693	2.086	982	63,79%
TOTAL			34.752	11.668	9.740	13.344	71,97%

From table 3.1 and table 3.2 data, it can be seen that Physical Availability (PA) for OB and Coal units has not been achieved from the target of 80%. And there is a downward trend with an average OB DUMP TRUCK 83.86% AND COAL DUMP TRUCK 71.97%, this indicates that there is a problem with the OB DUMP TRUCK and COAL DUMP TRUCK units, things that can cause Physical Availability (PA) not to be achieved are the number of breakdowns that occur and the length of time to repair the unit.

3.3.1.3 Mechanical Availability (MA)

Data taken at PT. XYZ, it was found that the Physical Availability (PA) data on January 23 – June 23, 2023 obtained the following results:

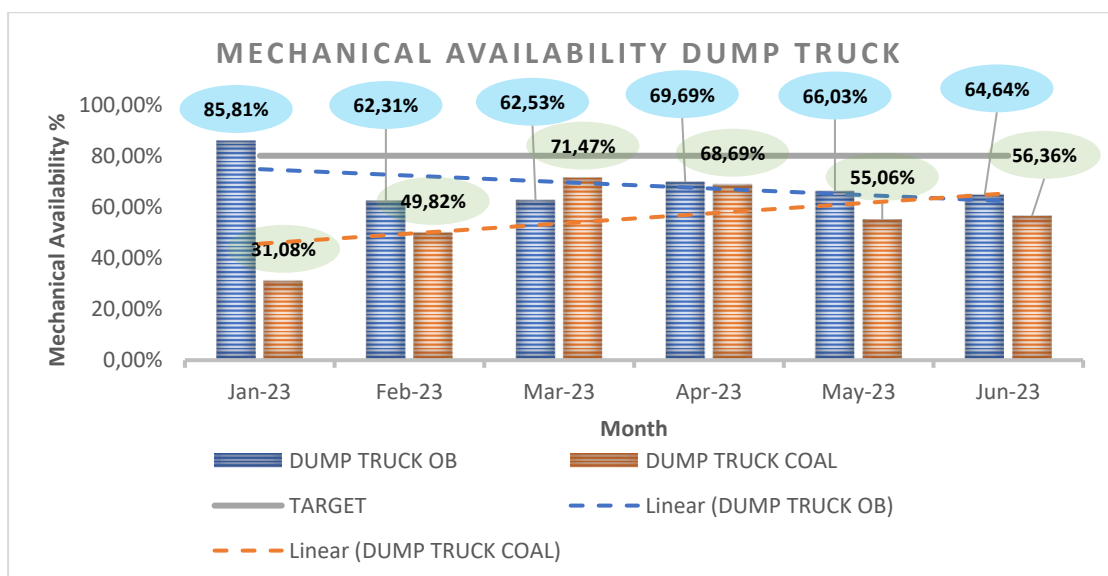


Figure 3.4 Mechanical Availability (MA)

Table 3.3 Mechanical Availability Dump Truck OB

No	Category	Month	Available Hours	Working Hours	Breakdown Hours	Stanby Hours	Mechanical Availability (MA)
1	DUMP TRUCK OB	Jan-23	16.368	4.226	699	11.443	85,81%
2	DUMP TRUCK OB	Feb-23	14.784	3.495	2.114	9.175	62,31%
3	DUMP TRUCK OB	Mar-23	16.368	4.258	2.551	9.559	62,53%
4	DUMP TRUCK OB	Apr-23	15.840	5.296	2.303	8.240	69,69%
5	DUMP TRUCK OB	May-23	16.368	7.144	3.676	5.548	66,03%
6	DUMP TRUCK OB	Jun-23	15.840	7.464	4.083	4.293	64,64%
TOTAL			95.568	31.883	15.426	48.259	67,39%

Table 3.4 Mechanical Availability Dump Truck COAL

No	Category	Month	Available Hours	Working Hours	Breakdown Hours	Stanby Hours	Mechanical Availability (MA)
1	DUMP TRUCK COAL	Jan-23	5.952	1.178	2.613	2.161	31,08%
2	DUMP TRUCK COAL	Feb-23	5.376	1.412	1.422	2.542	49,82%
3	DUMP TRUCK COAL	Mar-23	5.952	1.963	784	3.205	71,47%
4	DUMP TRUCK COAL	Apr-23	5.760	2.146	978	2.636	68,69%
5	DUMP TRUCK COAL	May-23	5.952	2.276	1.858	1.818	55,06%
6	DUMP TRUCK COAL	Jun-23	5.760	2.693	2.086	982	56,36%
TOTAL			34.752	11.668	9.740	13.344	54,50%

From the data of table 3.3 and table 3.4, it can be seen that the Mechanical Availability (MA) for OB and Coal units has not been achieved from the target of 80%. with an average OB DUMP TRUCK 67,39% AND COAL DUMP TRUCK 53,59%. The MA was not achieved due to the number of unit breakdowns that were quite high at 15.426 hours on the OB DUMP TRUCK unit and 9.740 hours on the COAL DUMP TRUCK unit.

3.3.1.4 Achievement of Production

Data taken at PT. XYZ, it was found that the Achievement of Production data on January 23 – June 23, 2023 obtained the following results:

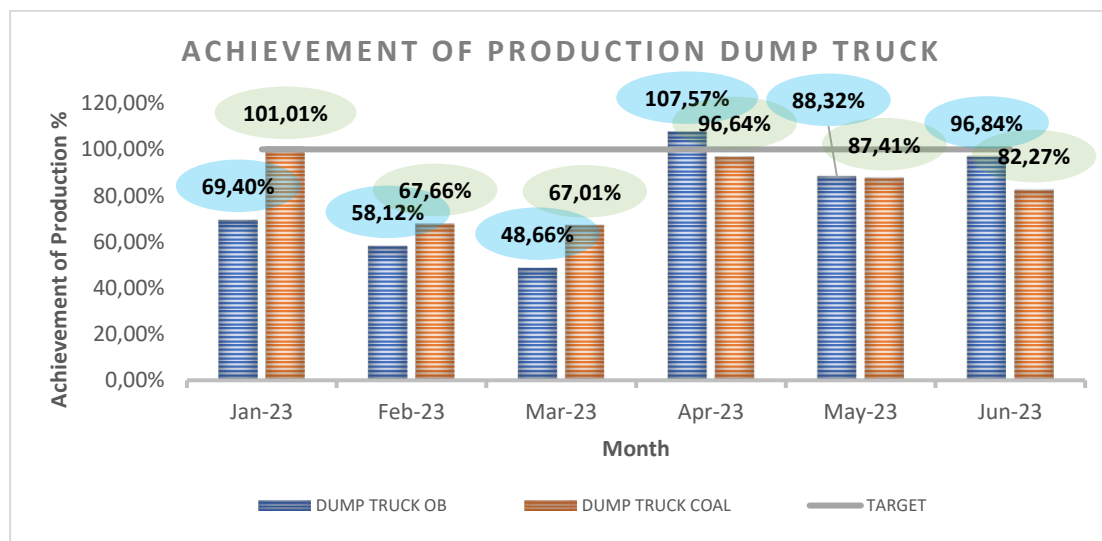


Figure 3.5 Achievement of Production (AP)

Table 3.5 Achievement of Production Dump Truck OB

No	Category	Month	Available Hours	Working Hours	Breakdown Hours	Standby Hours	Physical Availability (PA)	Productivity
1	DUMP TRUCK OB	Jan-23	16.368	4.226	699	11.443	95,73%	69,40%
2	DUMP TRUCK OB	Feb-23	14.784	3.495	2.114	9.175	85,70%	58,12%
3	DUMP TRUCK OB	Mar-23	16.368	4.258	2.551	9.559	84,41%	48,66%
4	DUMP TRUCK OB	Apr-23	15.840	5.296	2.303	8.240	85,46%	107,57%
5	DUMP TRUCK OB	May-23	16.368	7.144	3.676	5.548	77,54%	88,32%
6	DUMP TRUCK OB	Jun-23	15.840	7.464	4.083	4.293	74,22%	96,84%
TOTAL			95.568	31.883	15.426	48.259	83,86%	77,60%

Table 3.6 Achievement of Production Dump Truck COAL

No	Category	Month	Available Hours	Working Hours	Breakdown Hours	Standby Hours	Physical Availability (PA)	Productivity
1	DUMP TRUCK COAL	Jan-23	5.952	1.178	2.613	2.161	56,11%	101,01%
2	DUMP TRUCK COAL	Feb-23	5.376	1.412	1.422	2.542	73,54%	67,66%
3	DUMP TRUCK COAL	Mar-23	5.952	1.963	784	3.205	86,83%	67,01%
4	DUMP TRUCK COAL	Apr-23	5.760	2.146	978	2.636	83,02%	96,64%
5	DUMP TRUCK COAL	May-23	5.952	2.276	1.858	1.818	68,79%	87,41%
6	DUMP TRUCK COAL	Jun-23	5.760	2.693	2.086	982	63,79%	82,27%
TOTAL			34.752	11.668	9.740	13.344	71,97%	82,28%

From the data of table 3.5 and table 3.6, it can be seen that the Achievement of Production (AP) for OB and Coal units was not achieved from the target of 100%,

with an average OB DUMP TRUCK of 77,60% and COAL DUMP TRUCK 82,28%, because the working hours of the OB Dump Truck were smaller than the available hours of 31.883 hours (33,6%) while the COAL DUMP TRUCK unit also experienced the same thing, namely working hours smaller than the available hours of 11.668 (33,58%). This indicates that the use of the unit is still not optimal.

3.3.2 Data Analysis

3.3.2.1 Overall Equipment Effectiveness (OEE)

From the data above, analysis can be done, by calculating Overall Equipment Effectiveness (OEE) with the formula:

$$OEE = PA (\%) \times MA(\%) \times AP(\%) \quad (3.1)$$

Description:

OEE : Overall Equipment Effectiveness (OEE)

PA : Physical Availability

MA : Mechanical Availability

AP : Achievement of Production

Table 3.7 Overall Equipment Effectiveness (OEE) Dump Truck OB

No	Category	Month	Available Hours	Working Hours	Breakdown Hours	Standby Hours	Physical Availability (PA)	Mechanical Availability (PA)	Productivity	Overall Equipment Effectiveness (OEE)
1	DUMP TRUCK OB	Jan-23	16.368	4.226	699	11.443	95,73%	85,81%	69,40%	57,01%
2	DUMP TRUCK OB	Feb-23	14.784	3.495	2.114	9.175	85,70%	62,31%	58,12%	31,04%
3	DUMP TRUCK OB	Mar-23	16.368	4.258	2.551	9.559	84,41%	62,53%	48,66%	25,68%
4	DUMP TRUCK OB	Apr-23	15.840	5.296	2.303	8.240	85,46%	69,69%	107,57%	64,07%
5	DUMP TRUCK OB	May-23	16.368	7.144	3.676	5.548	77,54%	66,03%	88,32%	45,22%
6	DUMP TRUCK OB	Jun-23	15.840	7.464	4.083	4.293	74,22%	64,64%	96,84%	46,47%
TOTAL			95.568	31.883	15.426	48.259	83,86%	67,39%	77,60%	43,86%

Calculation:

$$OEE = 83,86\% \times 67,39\% \times 77,60\%$$

$$OEE = 43,86\%$$

Table 3.8 Overall Equipment Effectiveness (OEE) Dump Truck COAL

No	Category	Month	Available Hours	Working Hours	Breakdown Hours	Standby Hours	Physical Availability (PA)	Mechanical Availability (PA)	Productivity	Overall Equipment Effectiveness (OEE)
1	DUMP TRUCK COAL	Jan-23	5.952	1.178	2.613	2.161	56,11%	31,08%	101,01%	17,61%
2	DUMP TRUCK COAL	Feb-23	5.376	1.412	1.422	2.542	73,54%	49,82%	67,66%	24,79%
3	DUMP TRUCK COAL	Mar-23	5.952	1.963	784	3.205	86,83%	71,47%	67,01%	41,58%
4	DUMP TRUCK COAL	Apr-23	5.760	2.146	978	2.636	83,02%	68,69%	96,64%	55,11%
5	DUMP TRUCK COAL	May-23	5.952	2.276	1.858	1.818	68,79%	55,06%	87,41%	33,11%
6	DUMP TRUCK COAL	Jun-23	5.760	2.693	2.086	982	63,79%	56,36%	82,27%	29,58%
TOTAL			34.752	11.668	9.740	13.344	71,97%	54,50%	82,28%	32,28%

Calculation:

$$OEE = 71,97\% \times 54,50\% \times 82,28\%$$

$$OEE = 32,28\%$$

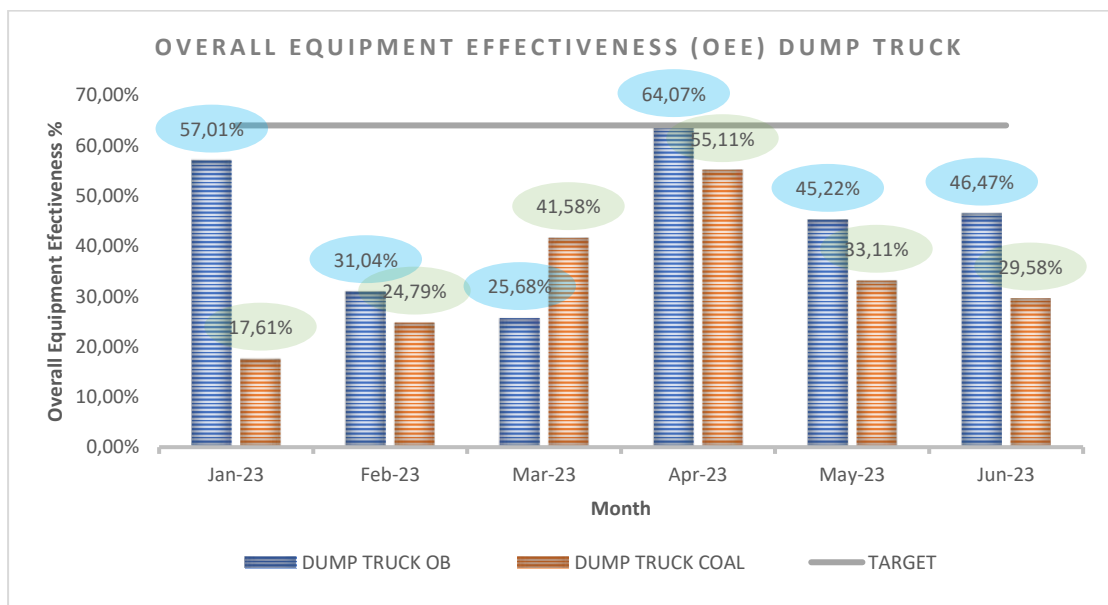


Figure 3.6 Overall Equipment Effectiveness (OEE)

Table 3.9 Target Overall Equipment Effectiveness (OEE)

Physical Availability (PA)	Mechanical Availability (MA)	Achievement of Production (AP)	Overall Equipment Effectiveness (OEE)
80,00%	80,00%	100,00%	64,00%

From the Overall Equipment Effectiveness (OEE) data above, it was found that the OEE value in the OB Dump Truck Unit was 43,86% and the OEE in the COAL

Dump Truck Unit was 32,28%, the value was still below the target of 64,00%, so improvement must be made.

3.3.2.2 Root Cause Analysis (RCA)

At this stage researchers use fishbone diagrams to find possible problems that occur in the problem of Physical Avail Ability Coal Dump Truck 71.97% Under 85%. Metode Fishbone diagram yang digunakan, mencakup 4 pembahasan yaitu man power, method, Tools, and Machine.

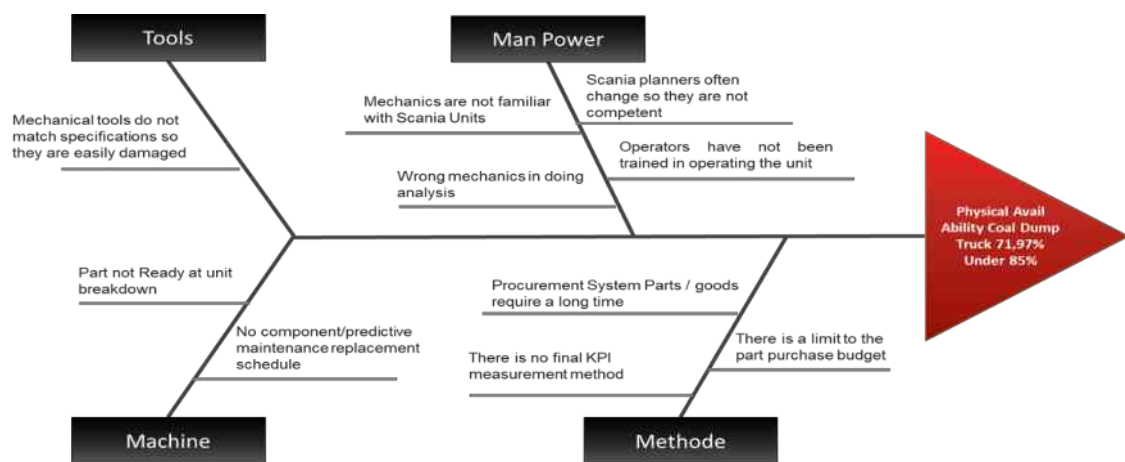


Figure 3.7 Fish Bone Diagram

Table 3.10 Problem and Causes Fish Bone

Problem	Causes
Physical Avail Ability Coal Dump Truck 71,97% Under 85%	Man Power
	1. Mechanics are not familiar with Scania Units
	2. Wrong mechanics in doing analysis
	3. Planners often change so they are not competent
	4. Operators have not been trained in operating the unit
	5. New Instructor Employee
	Method
	1. Procurement System Parts / goods require a long time
	2. There is no final KPI measurement method
	3. There is a limit to the part purchase budget
	Machine
	1. Part not Ready at unit breakdown
	2. No component/predictive maintenance replacement schedule

Problem	Causes
	Tools 1. Mechanical tools do not match specifications so they are easily damaged

3.3.2.3 - 5 Why

Table 3.11 -5 Why Analysis

No	Problem	Why 1	Why 2	Why 3	Why 4	Why 5	Solution
1	Instructors Rated Ineffective	Instructors often join the field	The instructor is still on job trainee status	New Instructor Employee	The old instructor resigned		1. Training Mechanical 2. Training Operation
2	The unit often breaks down	The mechanic is not thorough in carrying out repairs	Long time to repair of mechanics	The mechanic has not found the problem	Mechanic do not understand with scania system	Mechanics are not familiar with Scania Units	1. Training Mechanical 2. Evaluation Mechanic 3. Customer Maintenance Improvement Program
3	The unit often breaks down	Wrong mechanics in doing analysis	The mechanic is not thorough in carrying out repairs	The mechanic has not found the problem	Mechanic do not understand with scania system	Mechanics are not familiar with Scania Units	1. Training Mechanical 2. Evaluation Mechanic 3. Customer Maintenance Improvement Program
4	The unit often breaks down	Damage to the brake system area	often do blayer and coasting	Habit of operator	Operator does not know the operating procedures of the unit	Operators have not been trained in operating the unit	1. Training Operation 2. Evaluation Operators 3. Customer Operation Improvement Program
5	Part not Ready at unit breakdown	Part not available in warehouse	Part Delay Supply	Delay Create Purchase Order	No Preparation Part Order	Planners often change so they are not competent	1. Part Agreement Program
6	The unit often breaks down	Mechanical tools do not match specifications so they are easily damaged	Tools no spesification standart	Does not have a standard list of tools			1. Ordering tools with recommendation scania
7	Part not Ready at unit breakdown	Part not available in warehouse	New parts are ordered when the unit breaks down	Planner cannot predict the need for Unschedule backup parts	There is no predictive maintenance system yet	Planner no competent	1. Part Agreement Program 2. Customer Maintenance Improvement Program

No	Problem	Why 1	Why 2	Why 3	Why 4	Why 5	Solution
8	Part not Ready at unit breakdown	Procurement System Parts / goods require a long time	Parts are still in the process of being ordered from distributors	Waiting approval manager	Manager Must Check Stock and Check Budget to Order Parts	There is no part demand forecast	1. Part Agreement Program
9	Part not Ready at unit breakdown	There is a limit to the part purchase budget	There is no part demand forecast	Planner cannot predict the need for Unscheduled backup parts	There is no predictive maintenance system yet	Planner no competent	1. Part Agreement Program 2. Backlog maintenance system 3. Training Mechanical
10	Production Not Achieve	Physical availability unit rendah	The unit often breaks down	Mechanic and operator not competent	Mechanic and operator not familiar with unit scania	Mechanic and Operators have not been trained	1. Training Mechanical 2. Training Operation

From the 5 why analysis above, there are 4 problems, namely Instructors Rated Ineffective, The unit often breaks down, Parts not Ready at unit breakdown, and Production Not Achieved and obtained 6 alternative solutions, including:

1. Training Mechanical
2. Training Operation
3. Part Agreement Program
4. Customer Operation Improvement Program
5. Customer Maintenance Improvement Program
6. Backlog maintenance system

The alternative solutions above will be used as alternative programs carried out for improvement steps through the matrix diagram method.

3.3.2.4 Matrix Diagram

The matrix diagram in this study is used to determine the priority of the program to be carried out to make improvements. The matrix diagram method in this study uses 3 classifications of values, namely:

1. The value of 3 is used to choose programs that have a high impact to solve problems that occur in a fairly short time.
2. The value 2 is used to solve problems that have medium impact takes relatively longer than programs that have a value of 3.
3. The value 1 is given for the selection of programs that have a low impact on solving problems that occur so that they will become the last alternative solution.

After an assessment conducted in Focus Group Discussion (FGD) with experts, the results obtained will be summed up and then ranked according to the highest value. The highest value will be made a priority for the program that will be carried out in the improvement of this research.

Table 3.12 Matrix Diagram

Customer Need	Specific Problem		PROGRAM						Remark
			Training Mechanical	Training Operation	Part Agreement Program	Customer Operation Improvement Program	Customer Maintenance Improvement Program	Backlog maintenance system	
Machine Performance 85%	1	Instructors Rated Ineffective	3	3		3	3	2	3 = High Impact 2 = Medium Impact 1 = Low Impact
	2	The unit often breaks down	3	3	2	3	3	2	
	3	Part not Ready at unit breakdown			3			2	
Productivity	4	Production Not Achieve	3	3	2	3	3	2	
Total Value			9	9	7	9	9	8	
Rank			1	1	6	1	1	5	

Table 3.13 Summary Matrix Diagram

Priority	Program Name	Total Value
1	Training Mechanical	9
2	Training Operation	9
3	Customer Operation Improvement Program	9
4	Customer Maintenance Improvement Program	9
5	Backlog maintenance system	8
6	Part Agreement Program	7

From the results of the matrix diagram above, programs that can be carried out based on a priority scale with a value of 9 are mechanical training, operation training, customer operation improvement programs, and customer maintenance improvement programs. then the value 8 is the backlog maintenance system, and the value 7 is the part agreement program.

3.4 Improvement

In this research, the improvement step is to refer to the matrix diagram in process analysis, because the matrix diagram is the last step after observing data, calculating Overall Equipment Effectiveness (OEE), Focus Group Discussion, applying Fish Bone / Root Cause Analysis (RCA), and five why analysis.

3.5 Control

At this point, the following stages are necessary:

- b. Perform mechanical evaluation assessment
- c. PA improvement evaluation
- d. Evaluation of OEE improvements

3.6 Continue Improvement and Validation

The purpose of the study is to evaluate the results of the analysis that has been carried out to determine the level of significance of the research by means of feedback requests from participants, and then collect further data to test the results of the improvements that have been made. Success indicators are if the overall equipment effectiveness (OEE) methodology after repair is higher than the overall equipment effectiveness methodology (OEE) before repair and physical availability (PA) units increase from 65% to reach the target of 80%.

3.7 Timeline

Table 3.14 Time Activity of Project

