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Proposed Increasing Effectiveness of Heavy Equipment (Reach Stacker TEREX TFC 45 LX HC) At PT. Krakatau Argo Logistics Using the Total Productivity Maintenance Concept

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Abstract:- PT. Krakatau Argo Logistics is a company that works in the field of multimodal transportation services that serve land, sea and air transportation. One of the work processes of PT. Krakatau Argo Logistics uses the Reach Stacker TEREX TFC 45 LX HC heavy equipment. The effectiveness of the heavy equipment is still not optimal, this is inseparable from the problems caused by the six big losses. This study uses the Overall Equipment Effectiveness (OEE) measurement method, analysis of Six Big Losses calculations and Fishbone Diagram to find existing problems and provide solutions to fix these problems. From the measurement results, the average OEE value of Reach Stacker is only 40.44% with an average availability rate of 91.58%, an average Performance Efficiency of 63.12% and an average Quality Rate of 69.55%. These results have not yet reached the company's OEE target of 85% with Availability Rate >90%, Performance Efficiency >95% and Quality Rate >99%. The biggest factors affecting its effectiveness are reduce speed losses on average 43.92%, Idling & Minor Stoppages average 35.63%, Rework losses average 12.66%, and breakdown losses average 5.13%. So that the proposal for improving the Reach Stacker maintenance system of PT. Krakatau Argo Logistics is the application of the TPM pillar, namely autonomous maintenance to reduce the problem of six big losses so that there is an increase in effectiveness and the ideal OEE can be achieved.

Keywords:- *Six Big Losses; Overall Equipment Effectiveness; Total Productivity Maintenance.*

I. INTRODUCTION

The very dynamic development of technology and industry has made competition in the business world even tighter, especially in the economic field. In general, companies are established with the aim of obtaining an optimal profit. To achieve this goal is very fun, easy, according to the strategy and a good way to get it. Every organization or company in its operations always hopes that the goals that have been set can be achieved.

Cargo handling process at Integrated Slab Yard PT. Krakatau Posco did not reach the target, this was due to the poor performance of heavy equipment caused by damage to several heavy equipment used in the management of the Integrated Slab Yard, namely Reach Stacker, Elevation Truck and Truck Trailer.

The percentage of damage to heavy equipment within 1 year for 3 units of Reach Stacker is 52%, for 3 units of Elevation Truck it is 34% while for 15 units of trailer it is 14%. heavy equipment damage is dominated by the Reach Stacker. Damage Reach Stacker which is considered as the heart in the slab handling process is often a factor that affects the operation process at PT. Krakatau Argo Logistics where the efficiency of the company's performance is still below 95%. In addition, the OEE value is still far from the expectation that the ideal OEE value is 85% where the OEE of the Reach Stacker type heavy equipment is still below 50%.

II. THEORITICAL REVIEW

Maintenance is the main supporting activity that aims to ensure the functional continuity of a production system (equipment, machinery) so that when needed it can be used in accordance with the expected conditions. This can be achieved, among others, by planning and scheduling maintenance actions while still paying attention to their supporting functions and by taking into account the minimum cost criteria to anticipate damage and prevent the cessation of production activities.

The definition of the treatment itself according to Kurniawan (2013) is [1]:

- A combination of various actions taken to maintain an item or repair it until a condition is acceptable.
- A determination of work, methods, materials, tools, machines and employees at the time and time required.

A. Purpose of Maintenance Management

According to Ngadiyono (2010), in general the maintenance objectives are [2]:

- Ensure the optimum availability of the right equipment in order to fulfill the production activity plan and production process in order to obtain maximum return on investment.

- Extend the productive life of a work machine, building and all its contents.
- Ensure the availability of all necessary equipment in an emergency.
- Ensure the safety of everyone who is in and using the facility.

B. Types of Machine Maintenance

Engine maintenance is an important factor in keeping the engine in top condition. This is intended so that in the production process there is no congestion due to the condition of the machine being damaged and not primed. The maintenance activities carried out in the company/factory can be divided into two types, namely:

- Preventive Maintenance

Preventive maintenance is a maintenance activity carried out to prevent unexpected damage and find conditions or circumstances that can cause production facilities to experience damage when used in the production process. Preventive Maintenance includes, lubricating, cleaning, adjusting, and replacing small components to extend the life of equipment and facilities. The goal is to minimize damage and excessive shrinkage.

- Corrective or Breakdown Maintenance

Corrective maintenance is maintenance carried out after the occurrence of a malfunction in a facility or equipment that is not functioning properly. The activities carried out are often referred to as repair or repair activities. The purpose of this corrective action is so that the facilities or equipment can be reused in the production process, so that the production process can run smoothly again.

An effective maintenance system in maintaining industrial equipment is Preventive Maintenance where it can anticipate potential damage or system failure, minimize equipment downtime damage and maximize tool life.

C. Overall Equipment Effectiveness (OEE)

Borris (2010) states that OEE is a critical measurement carried out in the application of TPM to evaluate the ability of a machine/equipment in a production system. OEE consists of three main components, namely availability, performance, and quality [3].

One of the main goals of the OEE program is to reduce or eliminate the so-called six major causes of loss of efficiency. Six big losses are known as downtime losses which are useful for calculating machine availability [4]. Availability is the ratio of operation time, by setting aside machine downtime.

According to Nakajima (1988) companies that have successfully implemented Total Productive maintenance (TPM) have ideal values, namely [5]:

- Availability >90%
- Performance Efficiency >95%
- Quality product >99%

So the ideal OEE is: 0,90 x 0,95 x 0,99 = 85 %.

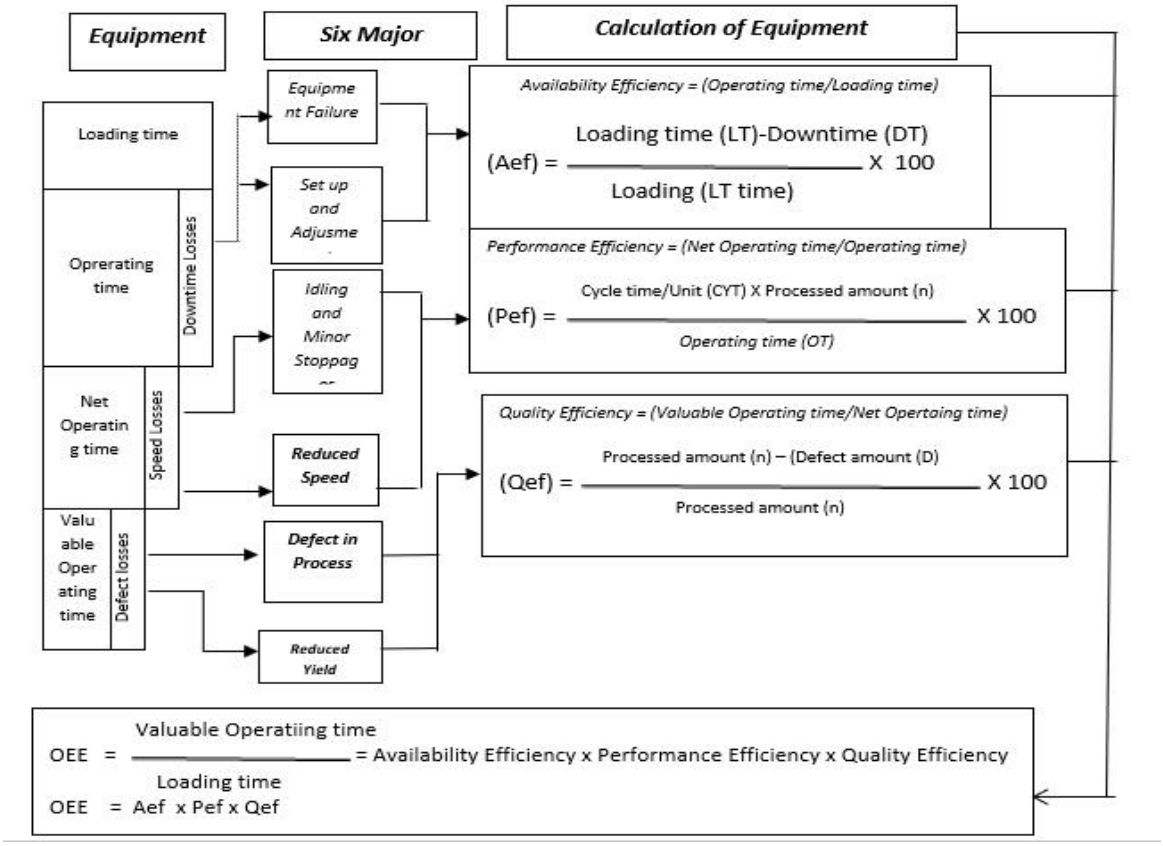


Fig. 1. Calculation of OEE Based on the six major production losses [5].

D. Total Productive Maintenance

According to Nakajima (1988) TPM (Total productive maintenance) is a program for the fundamental development of the maintenance function in an organization, which involves all of its human resources. If implemented comprehensively, TPM will be able to increase productivity, quality, and minimize costs [5].

Total Productive Maintenance (TPM) is a maintenance concept that involves all workers in the company. The goal is to achieve effectiveness in the entire production system through participation and productive maintenance activities, in TPM the involvement of everyone is emphasized. TPM is almost the same as Total quality control (TQC) where the involvement of everyone is the key to success in developing business quality to meet customer needs.

E. Pillars of TPM

Ahuja and Kahamba (2010) argue that TPM will provide a solution to obtain perfect results in planning, organizing, monitoring, and regulating the 8 pillars method, the pillars are as shown in Figure 2 [6].

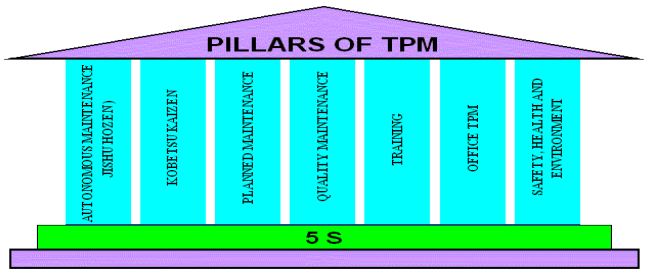


Fig. 2. Eight pillars of TPM [6].

F. Implementation of TPM

According to Patterson (1996) in Jiwantoro (2012) before TPM is carried out in a company, the company must have fulfilled 5S, currently 5S is widely adopted by various industries in various countries. 5S is the basis for shaping human behavior in order to have the habit of reducing waste in the workplace, the 5S program was first introduced in Japan as a movement of determination to carry out sorting (Seiri), Arrangement (Seition), Cleaning (Seiso), maintaining steady conditions (Seiketsu), and self-awareness of the habits needed to do a good job (Sheituke) [7].

G. Fishbone Diagram

Hamzah, (2010) has defined that root cause analysis, one of which is a fishbone diagram, as an analytical tool that can be used to find out the root cause of a problem [8]. Sharma (2011) states, the TPM implementation team must analyze each equipment and make necessary repairs [9]. To analyze cause and effect, we will conduct an analysis using a fishbone diagram which through this diagram will be able to identify the root causes and causes of the low effectiveness of heavy equipment at PT. Krakatau Argo Logistics.

The following will describe the general form of a cause-and-effect diagram or often referred to as a fishbone diagram or an Ishikawa diagram in accordance with the name of Dr. Kaoru Ishikawa from Japan introduced the diagram. The general form of a cause-and-effect diagram can be seen in Figure 3.

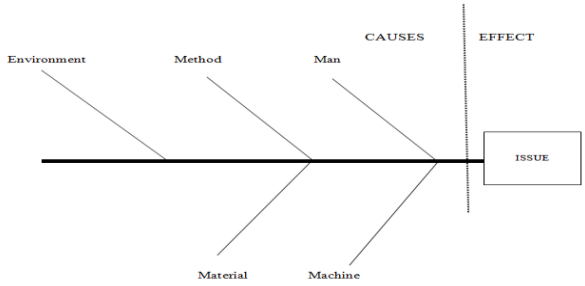


Fig. 3. General form of cause and effect diagram [8].

III. METODE

A. Research Design

This research is descriptive exploratory with the aim of obtaining an overview of the pillars of TPM which have a large positive influence in causing damage to heavy equipment.

B. Research Variables

According to the relationship between one variable and another, the research variables are divided into:

- Independent variable (independent variable, because it affects)

is a variable that affects or is the cause of the change or the emergence of the dependent variable [10]. The independent variables in this research are Overall Equipment Effectiveness, Six big losses and Root cause/fishbone diagram with 4M & 1E approach (Man, Method, Material, Machine & Environment).

- Dependent variable (dependent variable, output variable)

is a variable that is influenced or which is the result of the independent variable [10]. The dependent variable in this study is the OEE Standardization of Heavy Equipment PT. Krakatau Argo Logistics 85%.

C. Types & Data Sources

The types and sources of data in this study are primary data and secondary data.

- The primary data in this research is using the 4M&1E approach, through this approach it can be used as a guide to formulate the main factors in the process of making fishbone diagrams to find out the root cause of a problem.
- While secondary data is data which is company documentation, monthly reports on heavy equipment operations, monthly maintenance reports. This data is needed to calculate variables or factors for the effectiveness of heavy equipment for a period of 12 months starting from June 2016 to May 2017 in PT. Krakatau Argo Logistics.

D. Population and Research Sample

The population in this study were all heavy equipment data records (Reach Stacker). While the samples taken in this study were recorded data of heavy equipment (Reach Stacker)

for a period of 12 months starting from June 2016 to May 2017 at PT. Krakatau Argo Logistics.

E. Data Collection Method

In knowing the facts to deal with problems that are being experienced by the company. Accurate data is needed to support the results of actions and analysis in making decisions. The data collected is adjusted to the theoretical basis, broadly the data collection is divided into two parts, namely:

- Primary Data

Primary data collection is done by the following methods:

1) Field observations, observations are made directly on the work area of heavy equipment and observe the problems that occur.
2) Interviews, focus group discussions or Focus Group Discussions (FGD) conducted by 3 people where the author is the moderator and 2 (two) expert resource persons who are very knowledgeable in their field of work, namely Supervisor Integrated Slab Yard and Supervisor Maintenance PT. Krakatau Argo Logistics.
3) Using Brainstorming/fishbone diagrams with a 4M&1E approach, to analyze and find out the root causes of a problem and identify possible causes of a specific effect and then separate the root causes.

- Secondary Data

Secondary data is data that is not directly observed by researchers. This data can be in the form of company documentation, monthly operational reports, monthly maintenance reports at PT. Krakatau Argo Logistics, results of past research, and other data.

F. Data Analysis Techniques

- Secondary Data Analysis Techniques

Getting a better picture and solving the problems faced, with the OEE target not being achieved due to the six big losses factor, it is necessary to collect the data that has been obtained in advance according to the calculation method used. The method used is using Overall Equipment Effectiveness (OEE). So that the availability, performance and quality values are obtained which are factors in calculating the OEE value, measuring the six big losses with the following stages:

1) Calculating OEE

Below is a formula to see the OEE value in heavy equipment operational processes.

OEE = Availability X Performance X Quality (1)

$$\text{Availability} = \frac{\text{Operating Time}}{\text{Loading Time}} = \frac{\text{Loading Time} - \text{Downtime}}{\text{Loading Time}} \quad (2)$$

$$\textit{Performance rate} = \frac{\textit{Processed amount X Theoritical cycle time}}{\textit{Operating Time}} \quad (3)$$

$$\text{Quality rate} = \frac{\textit{Processed amount} - \textit{Defect amount}}{\textit{Processed amount}} \quad (4)$$

After the calculation is done, it can be seen how much the effectiveness of the heavy equipment is.

2) Measure Six Big losses

a) Breakdown Losses

Damage to machinery/equipment will result in wasted time which results in losses for the company. The percentage of the effectiveness of heavy equipment lost due to breakdown can be calculated by the following formula:

$$\text{Breakdown Losses} = \frac{\text{Total Breakdown Time}}{\text{Loading Time}} \text{X } 100\% \quad (5)$$

b) Setup & Adjusment

The disadvantage due to set-up and adjustment is the set-up time including adjustment time. The percentage of the effectiveness of heavy equipment lost due to set-up & adjustment can be calculated by the following formula:

$$\text{Setup \& Adjusment Losses} = \frac{\text{Total Setup \& Adjusment Time}}{\text{Loading Time}} \text{X } 100\% \quad (6)$$

c) Idling & Minor Stoppage

Losses due to operating without a load or due to a momentary stop arise if there are external factors causing the machine/equipment to stop repeatedly. The percentage of the effectiveness of heavy equipment lost due to Idling and Minor stoppage can be calculated using the following formula:

$$\text{Idling \& Minor Stoppage Losses} = \frac{\text{Non Productive Time}}{\text{Loading Time}} \text{X } 100\% \quad (7)$$

d) Reduced Speed

Is the time difference between the actual handling speed and the ideal machine speed. To find out the percentage of the amount of lost reduced speed losses can be calculated using the following formula:

$$\text{Reduced Speed} = \frac{\text{Operating Time} - (\text{Ideal cycle time x total production})}{\text{Loading Time}} \text{X } 100\% \quad (8)$$

e) Defect in process

Defect in process, which means that the heavy equipment does not produce performance in accordance with the specifications and product quality standards that have been determined. What is categorized as defect in process is rework losses. To determine the percentage of defects in process that affect the effectiveness of using the machine, the following formula is used:

$$\text{Rework Losses} = \frac{\text{Ideal cycle time x rework}}{\text{Loading Time}} \text{X } 100\% \quad (9)$$

f) Reduced Yield

Losses caused by defective products. To determine the percentage of Reduced yield that affects effectiveness, the following formula is used:

$$\text{Reduced Yield} = \frac{\text{Ideal cycle time x Scrap}}{\text{Loading Time}} \text{X } 100\% \quad (10)$$

- Primary Data Analysis Techniques

Primary Data Is data obtained from direct observation and research in the field, the primary data analysis technique used in this research is to perform root cause analysis (causal diagram), as an analytical tool that can be used to determine the root cause of a problem.

There are five main factors that need to be considered, including:

1) Cause due to Human (Man).
2) The cause is due to the work method (Work Method).
3) The cause is due to other work machines/equipment (Machine/Equipment).
4) Cause due to raw material (Material).
5) The cause is due to the work environment (Environment).

IV. RESULTS AND DISCUSSION

A company's OEE value can be said to meet the Word Class Standard if it meets the following criteria: Availability Rate > 90%, Performance Efficiency > 95%, Quality Rate > 99% and OEE greater than 85%. The achievement of the average OEE value from Reach Stacker is only 40.44% with an average availability rate of 91.58%, an average Performance Efficiency of 63.12% and an average Quality Rate of 69.55%. Thus, we can conclude that the OEE value of Heavy Equipment (Reach Stacker 01, Reach Stacker 02 and Reach Stacker 03) can be categorized in a condition that does not meet the standards set and the main focus of the low OEE value is obtained from the low Performance Efficiency and Quality Rate.

The following is a graph of the OEE value for each Reach Stacker analyzed:

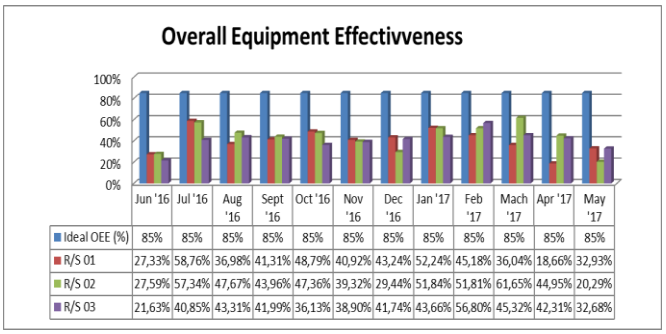


Fig. 4. Overall Equipment Effectiveness Reach Stacker value (processed secondary data)

A. Cause and Effect Diagram Analysis

Based on the results of the study, the causes of OEE not reaching the base target can be seen in the following table:

TABLE I. TABLE OF CAUSES OF OEE NOT REACHING THE BASE TARGET

No	Man	Machine	Method	Material	Environment
1	Operators have less responsibility for heavy equipment due to lack of motivation and supervision from superiors	Errors often occur in the unit system because the performance of the tool is too forced and the lack of preventive maintenance	There is no prevention of damage because repair work is carried out correctly and there is no automatic maintenance	The spare parts procurement process is too long	Damaged yard conditions and bumpy roads cause chains to often break because the tool carries heavy loads with unstable road conditions
2	Operators are less concerned with maintenance, less communicative, this happens because there is no reward & punishment and on jobdesc operators there is no involvement in repairs		Bed transfers often occur because the yard capacity is too small and the number of bed points is small	Inventory is not optimal because there is often zero stock and the MIN-MAX implementation has not yet started	Cleanliness is not maintained and operators are less disciplined towards 5R activities because there are no rewards & punishments
3	Mechanics are less focused due to work overload and limited members as well as non-shift work methods take a long time to make repairs on shift 2 and shift 3			The process of sending slabs from CCP to ISY is irregular due to unfocused operators and lack of supervision from superiors	

(Source: processed data)

The cause and effect diagram (fishbone diagram) can be explained in Figure 5 as follows:

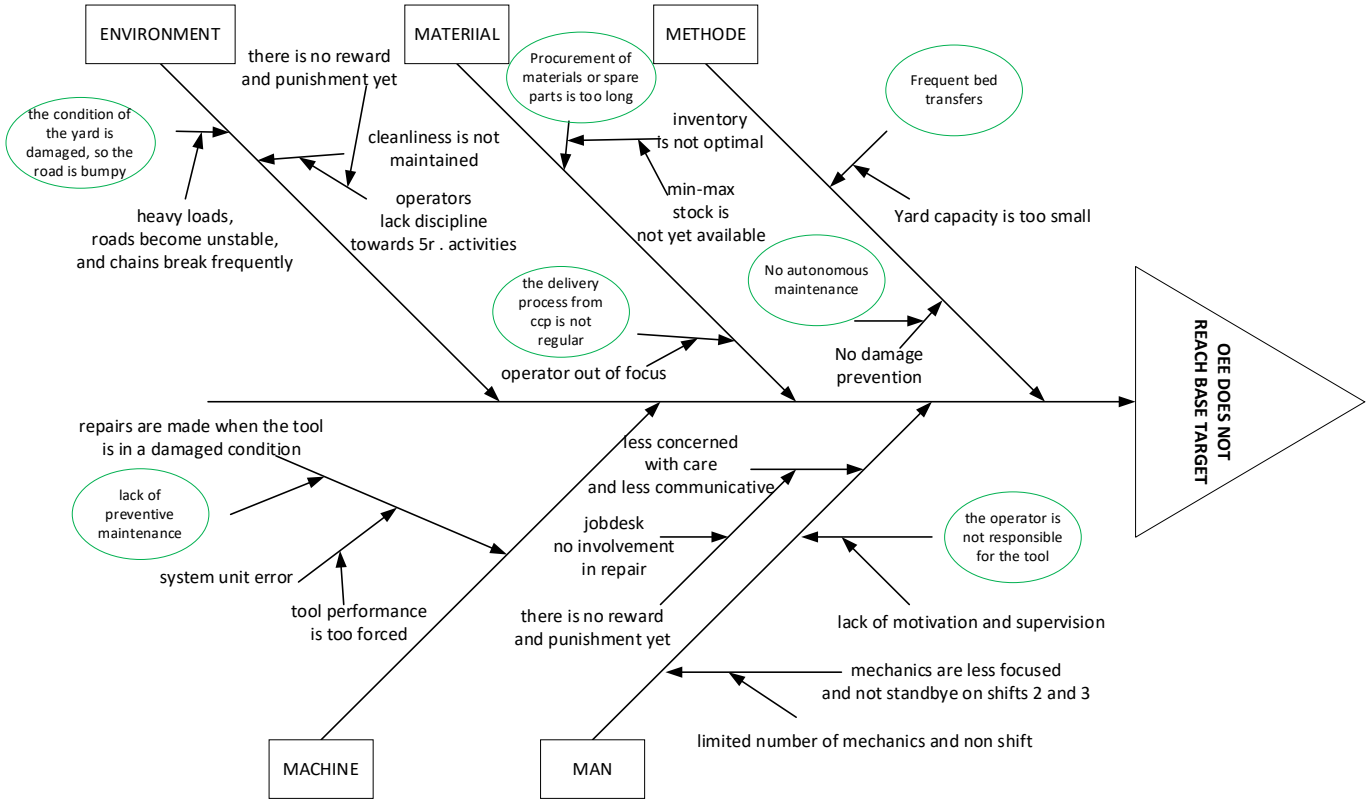


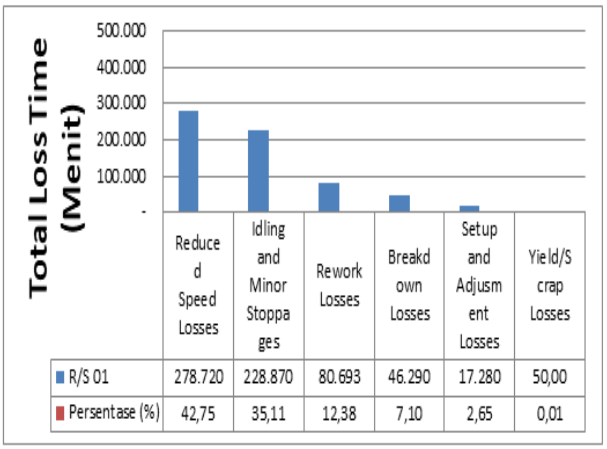
Fig. 5. Cause and Effect Diagram of OEE Not Reaching Base Target

The percentage of these six factors is more clearly observed in the form of a histogram as shown in Figure 4.3

	Breakdown Losses	Setup and Adjusment Losses	Idling and Minor Stoppages	Reduced Speed Losses	Rework Losses	Yield/Scrap Losses
R/S 01	46.290	17.280	228.870	278.720	80.693	50,00
R/S 02	30.060	17.280	234.180	296.537	81.769	40,00
R/S 03	24.180	17.280	234.180	284.484	85.268	45,00

Fig. 6. Histogram of the Six Big Losses Reach Stacker Factor Percentage for the Period June 2016-May 2017

From the results of sorting the percentage of the Six-big Losses factor, it will be illustrated with a Pareto diagram, it is clear that the order of the six factors that affect the effectiveness of the Reach Stacker can be seen in the following figure:



	Reduced Speed Losses	Idling and Minor Stoppages	Rework Losses	Breakdown Losses	Setup and Adjusment Losses	Yield/Scrap Losses
R/S 01	278.720	228.870	80.693	46.290	17.280	50,00
Persentase (%)	42,75	35,11	12,38	7,10	2,65	0,01

Fig. 7. Pareto Chart Percentage Factor of Six Big Losses Reach Stacker 01 Period June 2016-May 2017

From the picture above, it can be seen that the largest percentage of Six-big losses in Reachstacker 01 for the period June 2016 – May 2017 was in Reduced speed losses of 278,720 minutes or 42.75%, the second Idling and Minor Stoppages of 228,870 minutes or 35.11%, the third Rework Losses of 80,693 minutes or 12.38%, the fourth Breakdown Losses of 46,290 minutes or 7.10%, the fifth Setup and Adjustment Losses of 17,280 minutes or 2.65% and the sixth Yield/Scrap Losses of 50 minutes or 0.01%.

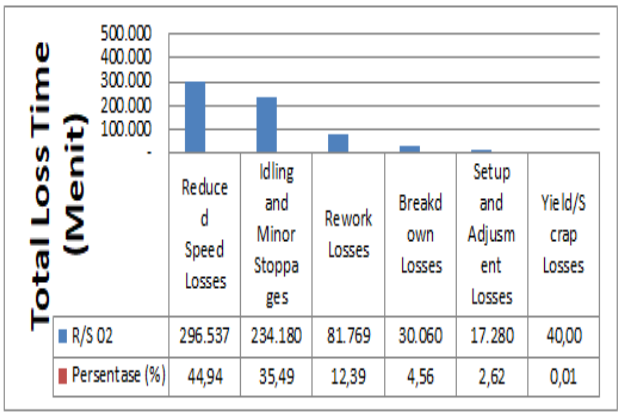


Fig. 8. Pareto Chart Percentage Factors of Six Big Losses Reach Stacker 02 Period June 2016-May 2017

From the picture above, it can be seen that the largest percentage of Six-big losses in Reachstacker 02 for the period June 2016 – May 2017 was in Reduced speed losses of 296,537 minutes or 44.94%, the second Idling and Minor Stoppages was 234,180 minutes or 35.49%, the third Rework Losses of 81,769 minutes or 12.39%, the fourth Breakdown Losses of 30,060 minutes or 4.56%, the fifth Setup and Adjustment Losses of 17,280 minutes or 2.62% and the sixth Yield/Scrap Losses of 40 minutes or 0.01%.

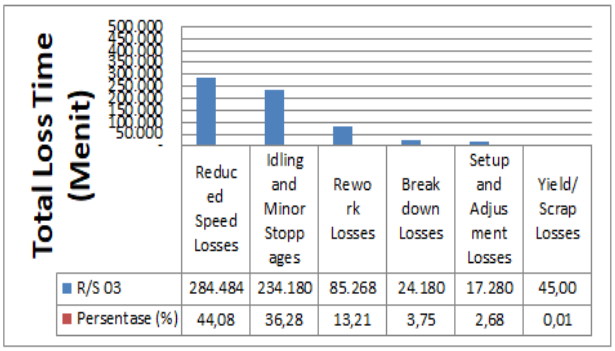


Fig. 9. Pareto Chart Percentage Factor of Six Big Losses Reach Stacker 03 Period June 2016-May 2017

From the picture above, it can be seen that the largest percentage of Six-big losses in Reachstacker 02 for the period June 2016 – May 2017 was in Reduced speed losses of 296,537 minutes or 44.94%, the second Idling and Minor Stoppages was 234,180 minutes or 35.49%, the third Rework Losses of 81,769 minutes or 12.39%, the fourth Breakdown Losses of 30,060 minutes or 4.56%, the fifth Setup and Adjustment Losses of 17,280 minutes or 2.62% and the sixth Yield/Scrap Losses of 40 minutes or 0.01%.

B. Research Implications for Industry

Proposed Troubleshooting to Reduce Six Big Losses

Based on the results of the analysis of the calculation of OEE and Six-big losses, it can be concluded that the main cause of the low effectiveness of the Reach Stacker is the high Reduced speed losses, Idling and minor stoppages, Rework Loses and Breakdown losses, so it is a priority for the company to make improvements as an initial step. in an effort to increase the effectiveness of the Reach Stacker so that the ideal OEE can be achieved.

To be able to increase the Effectiveness of the Reach Stacker, it is necessary to take steps to eliminate the dominant factors of the six big losses in this case Reduced speed losses, Idling and minor stoppages, Rework Loses and breakdown losses.

The following is a proposed solution to the problem to eliminate these four factors.

1) Take actions or efforts that can improve employee performance, with the following steps:

a) Increase employee motivation by giving rewards or awards to employees who provide solutions, ideas, ideas, improvements to the company so that the company is able to generate added value more than what has been set.

b) Improving employee skills by providing training to employees according to their competencies, so that employee competencies increase, so as to improve employee performance.

c) Evaluating employee performance regularly at least once in 6 months, so that employee performance can be monitored at any time.

d) Applying work discipline to employees in order to create a comfortable, fair, orderly working atmosphere in carrying out work.

e) Improve supervision of operators and provide strict sanctions against employees who are not disciplined.

f) Insert/add a job desk for heavy equipment operators to be involved in maintenance.

2) Take actions or efforts that can increase the effectiveness of the Reach Stacker, with the following steps:

a) a) Perform periodic maintenance, be it daily, weekly, monthly or yearly with the aim of preventing minor damage, such as lubricating, cleaning, setting and adjusting.

b) Monitoring (early detection) for early identification of damage to heavy equipment, such as monitoring vibration, calibration, temperature, amperage, pressure, and others.

3) Improving work methods by:

a) Applying the concept of Autonomic Maintenance (self-maintenance), with the aim that the mindset of operators who previously thought that operators only use heavy equipment and other people who repair them can be changed so that heavy equipment maintenance activities in the company can run well and damage can be prevented.

b) Cooperating with PT. Krakatau Posco regarding the arrangement of the production schedule. The production schedule should be arranged and adjusted based on the targets set by the company. With this arrangement, the process of sending slabs from CCP (Continues Casting Plan) to ISY (Integrated Slab Yard) is smooth and reduces idling and minor stoppages.

c) c) Modifying the bed points so that the inventory of the slab will increase after that it is necessary to add yards, this is done to minimize rework, in addition to naming the bed points to be repaired and using a signpost because the current condition is still using pylok on the floor and it is less visible This is done to minimize errors during the slab placement process.

4) Take actions or efforts related to the availability of materials / spare parts, with the following steps:

a) Each user from each department makes a Term of Reference so that there are no errors in the procurement process.

b) Cooperating with the procurement department regarding the availability of materials by implementing a consignment system in the procurement process for optimum inventory and implementation of MIN – MAX on inventory so that zero stock does not occur, especially for critical parts because the availability of materials/spare parts can reduce the risk of heavy equipment stopping/Breakdown too long because waiting for spare parts.

5) Efforts or actions taken related to environmental factors that affect the effectiveness of heavy equipment can be carried out with the following steps:

a) Investing in the implementation of improving the condition of the slab yard by leveling the ground, it would be very good if coor or concrete was carried out, with the current condition where bumpy roads affect the breakdown rate because chains often break and tire life is low.

b) Implementing the 5R system (Concise, Neat, Clean, Careful and Diligent) in the work area and heavy equipment. 5R is the basis for shaping human behavior in order to have the habit (habit) of reducing waste in the workplace, if heavy equipment is dirty it will certainly affect the life and effectiveness of heavy equipment.

c) Giving rewards to employees who are considered the best in implementing the 5R system in their work area, rewards can be in the form of awards, symbols on uniforms, points in salary increases and others, with this reward it will encourage employees to make their work areas look neat, clean and tidy. maintained.

C. Proposed Implementation of Total Productive Maintenance (TPM)

Based on the analysis of the dominant factors of the six big losses in this case Reduced speed loss, Idling & Minor Stoppages, Rework and breakdown losses, one of the causes of high losses in slab handling activities in the Integrated Slab Yard area of PT. Krakatau Argo Logistcs, heavy equipment operators have not been directly involved in handling heavy equipment, they still adhere to the old concept of "I run the heavy equipment and you repair the heavy equipment", meaning that maintenance and repairs are still carried out by the Maintenance department and this is considered detrimental to the company by high losses caused by human factors. Looking at the source of the problem above, it is recommended to apply the concept of Autonomous Maintenance to operators on Reach Stacker heavy equipment.

Autonomous Maintenance is the most important element in Total Productive Maintenance which explains how an operator does not only carry out production activities, but is also involved in simple maintenance activities, so that symptoms of damage can be detected as early as possible, so that damage can be prevented completely.

D. Comparison with Previous Studies

The results of this study indicate that one of the causes of the non-ideal OEE value is the low performance efficiency value of each Reach Stacker, the main factor is the increasing value of speed losses, the second factor is idle and minor stoppages, the third factor is rework losses, and the fourth factor is breakdown losses.

Previous studies that used OEE calculations, six big losses analysis, cause-and-effect diagrams and TPM are as follows:

1. V. Selviyanti (2015), research on the application of the OEE method to extend the service life of the Terex RT-775 Crane at PT. PEC-TECH Services Indonesia, the method used in this study is the calculation of the OEE value and the analysis of six big losses, the results of the study obtained an OEE value above 85% which is the JIPM standard with an achievement of 96.51%, with Availability of 97.27%, Performance 99.48% and Quality 99.74%. And the results of the calculation of the six big losses, the largest percentage of idling minor stoppages is 6.23%, the second is from breakdown losses of 1.51% and the third is from Set up / Adjustment of 1.34% [11].

2. Hamid et al (2018), The research was conducted by analyzing the performance effectiveness of the Turning Star SB-16 Machine with the TPM method at PT. Mitsubishi Indonesia. The method used in this study is the calculation of the OEE value, the analysis of six big losses and the causal diagram, from the results of the calculation the OEE value is generally still below the value of 85% which is the JIPM standard. OEE values ranged from 71.57% to 72.57%. And the results of the calculation of the six big losses, the largest percentage of idling and minor stoppages is 52.51% and the second is from reduced speed losses of 40.66%. not appropriate and to minimize this, it is proposed to implement TPM with an autonomous maintenance program [12].

The research conducted by V. Selviyanti, (2015), has similarities with this thesis research, namely calculating the OEE of TEREX heavy equipment with the OEE method and six big losses to find out six major losses and overcome these losses with the TPM concept, namely the proposed application of autonomous maintenance. While the difference lies in the focus of research, this study focuses on efforts to improve the implementation of the heavy equipment maintenance system with the TPM concept to increase the effectiveness of using heavy equipment, while the research conducted by V. Selviyanti, (2015) focuses on efforts to extend the life of heavy equipment [11].

The difference between the research conducted by Hamid et al (2018) and this thesis lies in the object of research, this study analyzes heavy equipment while the research conducted by Hamid et al (2018) analyzes production machines. The equation of the research conducted by Hamid et al (2018) with this thesis lies in the final proposal to solve the problem of low OEE values, namely implementing autonomous maintenance according to the TPM concept [12].

V. CLOSING

A. Conclusion

Based on the results of the above discussion, the following conclusions can be drawn:

a) Based on the results of the discussion, it was found that the Overall Equipment Effectiveness (OEE) of Reach Stacker PT. Krakatau Argo Logistics for the period June 2016 - May 2017 on average has not met the base target. PT. Krakatau Argo Logistics is 85% with Availability Rate > 90%, Performance Efficiency > 95% and Quality Rate > 99% while the OEE achievement on the Reach Stacker average is only 40.44% with an average availability rate of 91.58%, Average Performance Efficiency is 63.12% and Quality Rate is 69.55% on average.

b) The most dominant six-big losses for the first three Reach Stackers are reduced speed losses by an average of 43.92%, the second Idling & Minor Stoppages an average of 35.63%, the three Rework losses an average of 12.66 %, and the fourth average breakdown losses are 5.13%. Idling & Minor Stoppages losses are generally caused by human & material factors, rework losses are generally caused by human and environmental factors, while Reduced speed losses and breakdown losses are generally caused by human factors and inadequate maintenance systems.

c) Proposed improvements to the Reach Stacker maintenance system PT. Krakatau Argo Logistics is by implementing the TPM pillar, namely autonomous maintenance which aims to increase the level of operator sensitivity to the condition of the Reach Stacker, as well as increase the operator's ability to carry out independent maintenance so as to reduce the problem of six big losses and have an impact on increasing effectiveness so that the ideal OEE can be achieved.

B. Suggestion

Some suggestions that are expected to provide useful input for the company based on the results of this study are to make efforts to minimize the dominant factors of the six big losses in this case Reduced speed losses, Idling and minor stoppages, Rework Loses and breakdown losses by:

a) Take actions or efforts that can improve performance. Employee.

b) Take actions or efforts that can increase the effectiveness of Reach Stacker.

c) Improve working method.

d) Take actions or efforts related to the availability of materials / spare parts.

e) Carry out efforts or actions taken related to environmental factors that affect the effectiveness of heavy equipment.

C. Suggestions for companies

a) Performing Overall Equipment Effectiveness (OEE) calculations on each heavy equipment so that it is always carried out to obtain information related to continuous improvement programs (Continues improvement) so that the OEE value reaches the base target set by the company.

b) Organizing regular training programs for operators and maintenance personnel so that the capabilities and expertise of operators can increase so that they can detect symptoms before damage occurs, minimize equipment breakdown, and improve the company's maintenance system.

c) Instilling awareness to all workers from top management to the lowest level so that they can play an active role in efforts to increase the effectiveness of heavy equipment by introducing Autonomus Maintenance at meetings, conducting socialization campaigns, promotions and rewards.

D. Suggestions for Further Research

The suggestions for further research include:

a) It is necessary to carry out further/re-investigation in the future after the company implements the total productive maintenance development program so that an analysis can be carried out before and after the implementation of the TPM program on indicators of the effectiveness of heavy equipment at PT. Krakatau Argo Logistics

b) For further research development, it is expected to be able to analyze and evaluate further regarding efforts to increase the OEE value in accordance with the standards set by the company and can add variables that are adjusted to the implementation of total productive maintenance.

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