ISSN No:-2456-2165

Application of Total Green Productive Maintenance in the Soekarno Hatta Airport Water Treatment Unit using the Overall Equipment Effectiveness Method

Asep Rudiana Rachmat[1]; Dewi Nusraningrum[2]
[1]Master of Management, Universitas Mercu Buana Jakarta, Indonesia
[2]Lecturer of Masters in Management, Universitas Mercu Buana Jakarta, Indonesia

Abstract:- ***The water treatment*** **unit is a unit tasked with distributing clean water at Soekarno Hatta airport. In carrying out the maintenance process this unit has not implemented TPM** ***(total productive maintenance)*** **in its entirety, even though implementing TPM is important because it can improve the performance of centrifugal pump equipment as the main driver. clean water at Soekarno Hatta airport using the OEE and** ***six big losses calculation method*****. The implementation of green TPM has not been running optimally, with many corrective maintenance processes still causing quite long** ***loading times*** **and** ***breakdown times*** **. This incident was caused by the condition of spare parts not being properly recorded, personal conditions that were still lacking in the nomenclature of this unit. and the TPM pillars have not been implemented to support the eco airport program launched by the Company.** ***The water treatment*** **unit has 26 centrifugal type main distribution pumps which will be used as research media. Data collection was carried out by conducting direct checks in the field and conducting** ***group discussion forums*** **(FGD) with the** ***water treatment unit technical team*****. From the results obtained through calculating OEE and** ***Six big losses*** **on these 26 main distribution pumps, the OEE value on the pumps was still below the value of 85 % according to world standards. By implementing TPM, it is hoped that the pump maintenance process can be more optimal so that it can reduce the value of** ***losses*** **on the main distribution pump and can increase the OEE value on the pump.**

Keywords:- *Total Productive Maintenance, Six Big Losses, OEE.*

I. INTRODUCTION

Hatta Airport is currently the busiest airport in Indonesia with serve departure passenger approximately 19,817,893 in the period in 2022 (Central Statistics Agency, 2022). With its growing condition flight Now it's definitely being demanded excellent service to serve user Airport services, such as service electricity and water. According to Meidya Qatrunada and Dyahjatmayanti, (2022) Annex 14 of ICAO (International Civil Aviation Organization) airports are certain areas on land or waters (incl buildings, installations and equipment) intended Good in a way whole or partly for arrival, departure and movement aircraft. The need for clean water at the airport is very important thing in support sustainability airport operations.

In terms of Clean water services at Soekarno Hatta Airport are managed by the Water Treatment unit, where the task is The principal and function of this unit are: give clean water supply to all areas of Soekarno Hatta Airport. To do preventive and corrective activities for each equipment used in supplies water like pump, network piping and accessories piping. Need The clean water supply at Soekarno Hatta Airport is as big as 9000 M 3 in One day (Report clean water use, 2022). Novianti and Sulistyorini, (2022) said drinking water is water that goes through a processing process or without processing fulfil conditions and can be drunk immediately. This Water Treatment Unit supplies clean water to the entire airport area with uses 10 main booster pumps and 3 pumps supporter as well as added with auxiliary boosters on each terminal. The pump own Different capacities include 3 pumps with capacity 160 Kw, 1 pump with capacity 90 Kw, 4 pumps with capacity 55 Kw, 2 pumps with capacity 15 Kw, and 4 tanks water reservoir with capacity accommodate every tank amounting to 4000 M3. In operation this pump is operational in a way alternate with operating hours for 12 hours a day each pump.

There is an increase use of clean water at the airport of course just also has an effect on improvement Power electricity usage pump, this increase is influenced by one of them with enhancement pump motor performance in move pump for distributing clean water. Enhancement Power This electricity aside affected by the increase water usage however also influenced by conditions performance insufficient pump good with exists leaks in the pump unit and poor condition of the pump bearings Good so that cause resulting in loud motor rotation frequency and power electricity through the inverter becomes increase.

There is an increase clean water use and increase energy electricity, this unit is required to continue increase performance on the line production and maintenance are not regardless from ability management company in manage source Power company to support the green airport program launched by the company. Hence it all tool production is demanded must Keep going in suitable prime condition with

ISSN No:-2456-2165

related SKEP 157 of 2003 guidelines and reporting equipment Airport electronics and electricity, and for fixed operate sustainability business company, required support from management to carry out industrial sustainability in all line business One of the companies is clean water distribution, of course with standardization that has been set must obeyed by all human flight. Refer to regulation there is a number of There are no Water Treatment unit facilities yet reach standard Availability level with the rules above .

According to Syahrial and Nusraningrum, (2022) TPM (total productive maintenance) can used to determine level damage and identify source problem as basis for making recommendation repairs and maintenance to reduce level damage, meanwhile Ahdiyat and Nugroho, (2022) explain that TPM (total productive maintenance) is a useful system for eliminating or reduce level damage machine.

In running activity maintenance facilities at the Water Treatment unit not yet walk with Good in accordance with what is stated in the standard operational procedures (SOP), because Still many activity outside repairs plan, which causes time stop operation facility as well as exists constraint like limitations personnel, limited consumable parts due to No managed with Good. Consequence from activity no routine maintenance walk with Good so that result frequency activity sufficient improvement high , with the OEE value data obtained in 2022 showing where the conditions are maintenance Not yet walk with OK , this is because Not yet walking implementation of TPM pillars as foundation to do maintenance, one of them is with implementation of autonomous maintenance that has not yet been implemented walk with OK, so in do data collection goods or spare part stock yet walk maximum.

With Still often happen activity repair facilities, with image data above there is mutual factors associated with personal condition of the Water Treatment unit technician, in daily operate activity operational team technical officer on duty each shift only 3 to with 4 people, of course just with many activity this improvement became constraint in do activity routine maintenance on this unit's facilities.

II. LITERATURE REVIEW

A. Total Productive Maintenance

Daman and Nusraningrum (2020) said that Total Productive Maintenance was first defined in the 1970s by Seiichi Nakajima from the Japan Institute of Plant Maintenance, TPM is a philosophy that aims to maximize the effectiveness of facilities used in industry, which is not only aimed at maintenance, but on all aspects of the operation and installation of production facilities, including increasing the motivation of people working at the enterprise to take part in equipment maintenance. TPM also has the goal of zero breakdown and zero product damage. With this aim, the level of tool use will increase, costs and supplies will decrease, and subsequently employee productivity will increase, Daman and Nusraningrum, (2020). Apart from that, the aim of TPM is to increase the effectiveness of machines or equipment and maximize output (PQCDSM - Productivity, Quality, Cost, Delivery, Safety, Morale) by trying to avoid damage to machines or equipment, losses due to reduced speed of machines or equipment, damage to goods in process production. By maximizing equipment, minimizing costs, and involving all members of the organization together in reducing the so-called (six major losses).

B. Treatment System

In management maintenance There is system maintenance is possible controlled such as: maintenance replacement components, maintenance control, total maintenance, and maintenance reliability. Management system maintenance done with objective give guarantee to functioning facility production, as well happen good interaction between humans and machines in the production process. Management system maintenance integrated own role important in reach vision company. System maintenance integrated own element in form facilities (machines), replacement components (materials), costs care (money), planning activity maintenance (method), mutual maintenance operator (man). related and interacting in activity maintenance in industry. The term maintenance is often used and interpreted as care or maintenance. Maintenance or upkeep is a concept of activities needed to maintain the quality of the machine so that it can function properly in its normal condition. Maintenance is a form of activity carried out to restore or maintain the condition of a machine so that it can always function. Maintenance is also a supporting activity that ensures the continuity of machines and equipment so that when needed they can be used as expected. So maintenance activities are a whole series of activities carried out to maintain machines and equipment in operational and safe condition, and if damage occurs it can be controlled Pranowo, (2019). Maintenance process can depicted as an input output model Maintenance process will influence level availability of facilities production, rate production, quality product end (end product), costs production, and safety operation. These factors will then influence the company's level of profit (profitability). The maintenance process not only helps the production process run smoothly due to timely delivery of products, but also keeps facilities and equipment effective and efficient and avoids damage (zero breakdown).

C. Maintenance Objectives

Generally maintenance focused on prevention to reduce and/ or avoid damage with ensure reliability and readiness equipment, as well minimize cost care (Pranowo, 2019). Maintenance process is a sub system from system production. System production itself own objective :

- Maximize profits from available market opportunities
- Minimize losses resulting from production failures
- Pay attention to technical and economic aspects of the production process.

➢ *The Main Objectives of a Maintenance Management System can be Briefly Stated as Follows:*

- Extending the service life of production facilities
- Guarantee the optimal level of availability of production facilities
- Ensure operational readiness of all facilities required for emergency use
- Ensure the safety of operators and facility users
- Supporting the machine's ability to suit its function helps reduce the use and storage of spare parts out of bounds
- Achieve the lowest possible level of maintenance costs by maintaining effectively and efficiently
- Collaborating closely with other main functions in achieving the company's main goals, namely maximum profits and low total costs.

D. Overall Equipment Effectiveness (OEE) Method

Betrian and Robby, (2022) said This OEE measurement is based on measurements three ratio main, namely (1) Availability ratio, (2) Performance ratio, and (3) Quality ratio. Meanwhile (Nusraningrum and Senjaya, 2019; Syahrial and Nusraningrum, 2022) Overall Equipment Effectiveness (OEE) is method Comprehensive measurements to demonstrate level productivity and performance something machine or equipment. Overall Equipment Effectiveness (OEE) measurement is also possible used as indicator success the application of Total Productive Maintenance for a continuous improvement process, the measurement of Overall Equipment Effectiveness (OEE) is based on on three measurement ratio that is ratio availability, ratio performance and ratios quality.

E. Six Big Losses

Daman and Nusraningrum, (2020) Says in system maintenance, available the term Six Big Losses (SBL), six big losses are loss must be avoided by everyone company. Six Big Losses has the meaning, namely six possible losses lower level effectiveness something machine. Therefore, to improve productivity machines / equipment, necessary done analysis productivity and efficiency engine on six loss big the with method as follows.

➢ *Breakdown Losses*

According to (Adelia & Al- Faritsy, 2022) via the journal six big losses is losses caused by defects equipment and needs repair. With Formula as follows:

Breakdown losses = (breakdown time) / (loading time) x 100%.....(5)

➢ *Setup and Adjustment Losses*

Loss time caused by machine set up before start the production process . With method calculation as follows:

$set\ up\ and\ adjusment\ losses$ = (set up time) / (loading time) x 100%.....(6)

➢ *Idling and Minor Stoppage Losses*

Losses caused _ Because machine stop in short time and must be restarted and not required repair . With method calculation as follows:

$iddling\ and\ minor\ stoppage\ losses$ = (non-productive time)/(loadingtime)x100%……...(7)

➢ *Quality Defect and Rework*

Losses caused Because product No produced with Correct from beginning of the process. With method calculation as follows:

$Defect\ Losses = Ideal\ cycle\ time\ x\ total\ produk\ defect$ $loading\ timex$ 100% (Ideal cycle time x total product defect) / (loading time) x 100%.....(8)

➢ *Yield/Scrap Losses*

Scrap/Yield Loss Losses caused Because exists defects early in the production process . With method calculation is as follows:

$Scrap\ Losses$ = (Ideal cycle time x scrap)/(loading time) x 100%.....(9)

➢ *Reject Losses*

Reject losses Losses consequence arise defective product _ or No meets product output standards and does not can done repeat.

Reject losses = (Ideal cycle time x reject)/(loading time) x 100%.....(10)

F. Centrifugal Pump

According to Kurniawan, (2022) Pumps are equipment lots of mechanics used in the industrial world nor House stairs, basically pump serves to raise pressure from fluid pressurized low become fluid pressurized high, in general pump used to drain fluid from plain low to higher ground and also as amplifier rate Genre moment pass obstacle like turn , difference pressure and obstacles difference height , pump This distribution is divided in a number of type pump one of them is pump centrifuge. Whereas according to Haryadi et al, (2022) pump centrifugal shared into two components main namely impeller and volute. The impeller is a rotating pump component, while the volute is a stationary pump component. The geometry of the impeller is the most influential parameter in pump performance. The geometry of the impeller affects the radial force, flow velocity, and also the resulting outlet pressure. There are several studies on centrifugal pumps with various methods, such as research on testing the effect of pump rotational speed on pressure fluctuations of centrifugal pumps, which states that pressure fluctuations can increase vibrations in the pump where these vibrations will reduce the efficiency of the pump, research on flow characterization in centrifugal pumps, cavitation phenomena, vibration detection in centrifugal pumps, and others. Optimizing the performance of centrifugal pumps can reduce production and maintenance costs in the industrial world. Centrifugal pumps have been widely used in various industries such as oil and gas, agriculture, chemistry and other sectors.

ISSN No:-2456-2165

G. Cause and Effect Diagram

Cause and Effect Diagram or also known as (Fishbone Diagram) is a tool (tools) in 7 management tools which is intended to identify and display interrelated integrated relationships between a cause and effect so that the root cause of a problem can be produced. Nugroho et al. (2017) stated the importance of cause and effect diagrams or fishbone diagrams as a development or improvement tool that can be carried out using non-numerical data to identify and coordinate potential causes and effects.

➢ *Based on These Theories, the Framework for this Research is as Follows:*

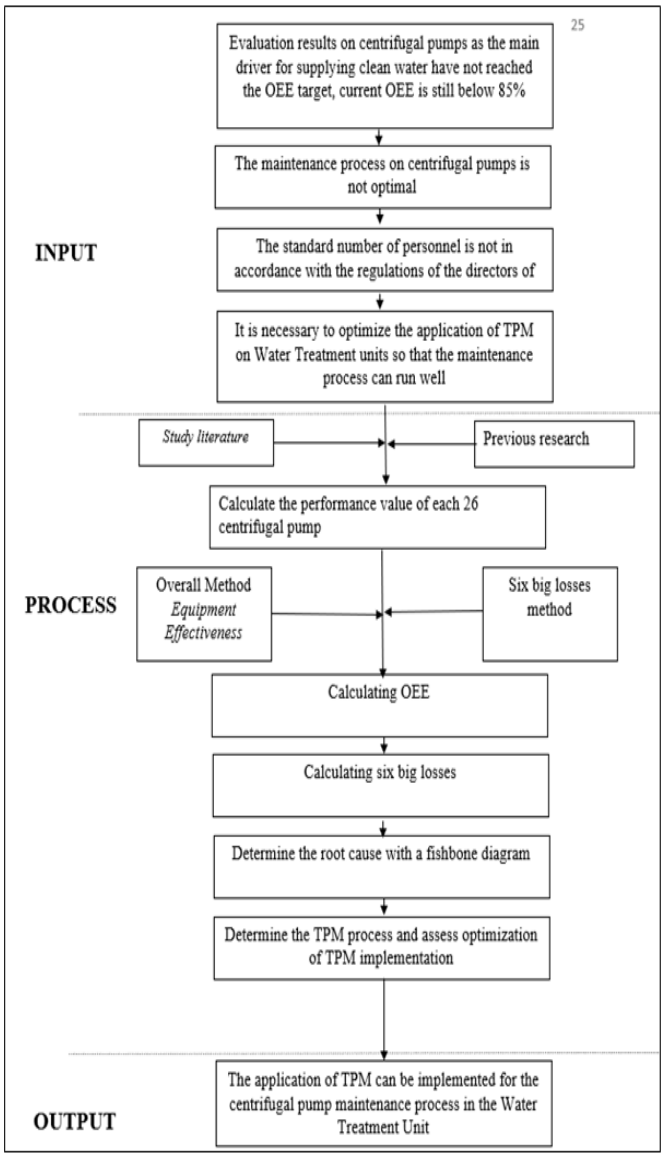

Fig 1 Framework Thinking

III. RESEARCH METHODOLOGY

Research carried out in this thesis proposal is to implement studies management operation related implementation of total productive maintenance on the Water Treatment unit as well get possible factors repair level quality of maintenance on the Water Treatment unit. This research was conducted with apply method mixed method research based on methods calculation of overall equipment effectiveness, calculation of the six big losses on the pump centrifuges, and related data processing history maintenance pump centrifugal the. In this writing it will be done study related serviceable level, available with use OEE method on 26 pumps centrifuges in the Water Treatment unit. As for time or timetable from this research was carried out moment researcher are in the 3rd semester on site live, Mercubuana university and data collection area.

In this research the author will do implementation of total productive maintenance with The OEE method in the Water Treatment unit is available several variables such as: Total productive maintenance, maintenance, pumps centrifuges, OEE and six big losses.

In this research the author use One of the non - probability sampling methods is using saturated sampling sample pump centrifugal distribution of clean water at Soekarno Hatta Airport a total of 26 pumps consisting of from 13 pumps distribution The main ones are in the Water Treatment unit, 6 pumps in terminal 1 and 7 pumps in terminal 3. According to Sugiyono, (2021) Saturated sampling is sampling which if added the amount No will add representativeness so that No will influence mark information obtained.

IV. RESULTS

A. Six Big Losses Value Processing

➢ *Calculation of Breakdown Losses*

- *January*

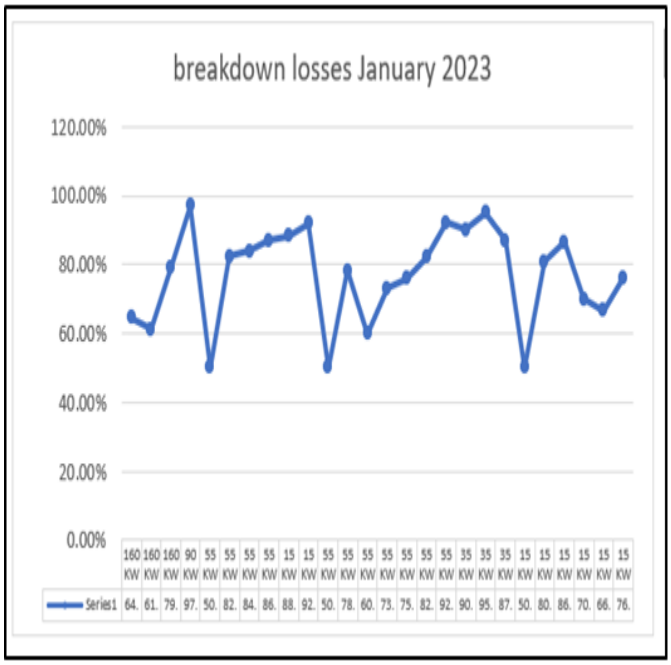

Fig 2 Breacksown Losses January

From calculation data pumps that experience the highest breakdown losses is pump with resulting capacity of 90 KW exists bearing and system damage pump panel components.

- *February*

Fig 3 Breacksown Losses February

From calculations on is known pump with capacity of 55KW located at terminal 3, this pump experiences component failure control such as relays and contactors pump, Where at the time this calculation is carried out spare parts are required done replacement not available.

- *March*

Fig 4 Breacksown Losses March

From the calculation above pumps that experience the greatest level of breakdown losses is pump 55K number 4 in terminal 3, this pump experienced leak in the seal mechanic pump where this pump should be done demolition in a way complete to replace seal faulty mechanics with the new one.

- *April*

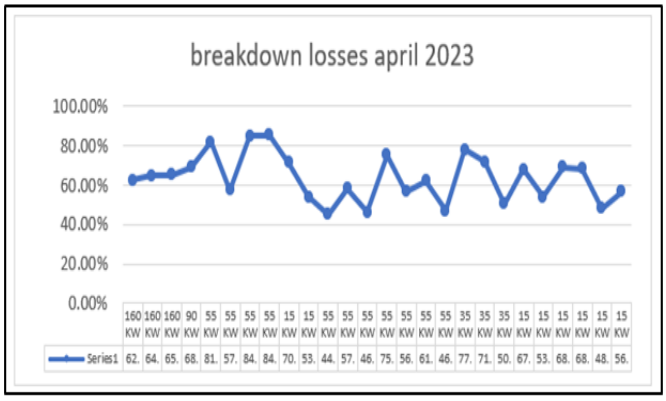

Fig 5 Breacksown Losses April

From the results In the calculation above , the pump experienced the largest breakdown losses is pump capacity 55 KW number 1 in the water treatment unit, where rubber clutch experience resulting damage performance pump decrease.

- *May*

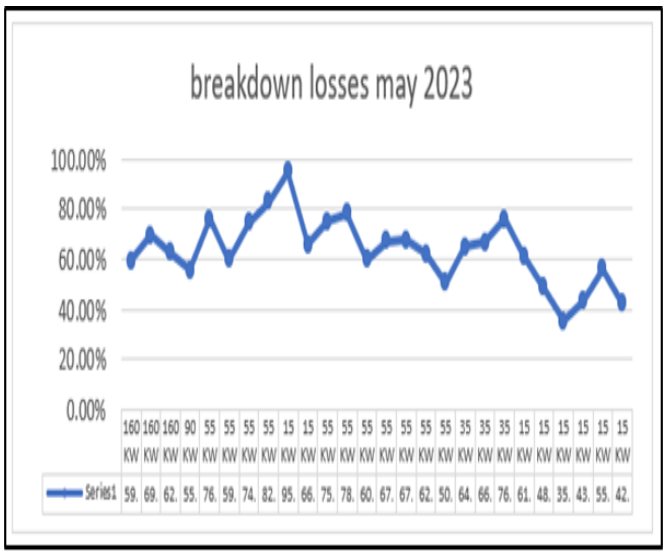

Fig 6 Breacksown Losses May

From results calculation on pumps that experience the largest breakdown losses is pump capacity of 15KW in the water treatment unit, this pump experiences damage to the network piping Where is the condition of the pump input valve damaged or not can monitored by the system control.

- *June*

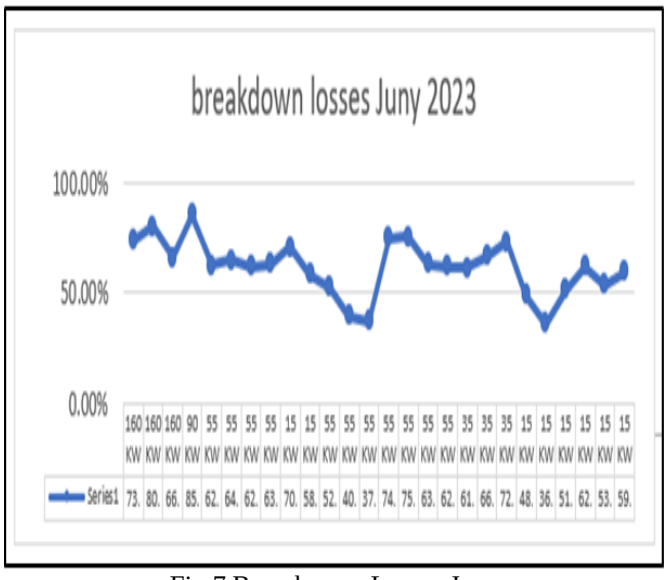

Fig 7 Breacksown Losses June

From the results In the calculation above , the pump experienced the largest breakdown losses is pump capacity of 90 KW in the water treatment unit, where rubber clutch experience resulting damage performance pump decrease.

ISSN No:-2456-2165

- *July*

Fig 8 Breacksown Losses July

From calculations on pump with the highest breakdown losses on the pump distribution of 160 KW number 2 in the water treatment unit, pump this experience disruption to function control pump, damage the originate from the pump MCC panel where it is mounted on the dol pump MCCB so that cause delivery Electric power on the pump become No stable.

➢ *Calculation of Yield/Scrap Losses*

Scrap/Yield Loss Losses caused Because exists defects early in the production process. With method calculation is as follows:

- *Scrap/Yield Loss = (0.39 x 0.02) /15 x 100% = 0.05%.*

For calculating Scrap/Yield Losses on pumps another calculation for January 2023 was found The largest Scrap/Yield Losses value is at the 15 KW pump in terminal 1, because exists the contactor does not Work optimally.

- *This Scrap/Yield Losses Calculation will be Starting at a 160 KW Pump with Calculation as Follows*

Scrap/Yield Loss = (0.47 x 0.02) /9.5 x 100% = 0.10%.

For calculating Scrap/Yield Losses on pumps another calculation for February 2023 was found The largest Scrap/Yield Losses value is at the 35 KW pump in terminal 1, because there are relays on the control panel broke up, and done replacement.

- *This Scrap/Yield Losses Calculation will be Starting at a 160 KW Pump with Calculation as Follows*

Scrap/Yield Loss = (0.43 x 0.02) /9 x 100% = 0.10%.

For calculating Scrap/Yield Losses on pumps another for March 2023 calculations found The largest Scrap/Yield Losses value is at the 55 KW pump in the water treatment unit, because exists shifting the limit switch on the pump's motorized valve.

- *This Scrap/Yield Losses Calculation will be Starting at a 160 KW Pump with Calculation as Follows*

Scrap/Yield Loss = (0.49 x 0.02) /4.5 x 100% = 0.22%.

For calculating Scrap/Yield Losses on pumps another for April 2023 calculations found The largest Scrap/Yield Losses value is at the 55 KW pump in the water treatment unit, because exists shift the limit switch on the pump's motorized valve.

- *This Scrap/Yield Losses Calculation will be Starting at a 160 KW Pump with Calculation as Follows*

Scrap/Yield Loss = (0.35 x 0.02) /15 x 100% = 0.05%.

For calculating Scrap/Yield Losses on pumps another calculation for May 2023 was found The largest Scrap/Yield Losses value is for the 15 KW pump in the water treatment unit, the contactor is not can Work in a way maximumBb.

- *This Scrap/Yield Losses Calculation will be Starting at a 160 KW Pump with Calculation as Follows*

Scrap/Yield Loss = (0.41 x 0.02) /9.4 x 100% = 0.09%.

For calculating Scrap/Yield Losses on pumps another for June 2023 calculations found The largest Scrap/Yield Losses value is for the 15 KW pump in the water treatment unit, the contactor is not can Work in a way maximum.

- *This Scrap/Yield Losses Calculation will be Starting at a 160 KW Pump with Calculation as Follows*

Scrap/Yield Loss = (0.41 x 0.02) /8 x 100% = 0.10%.

For calculating Scrap/Yield Losses on pumps another calculation for July 2023 was found The largest Scrap/Yield Losses value is at the 55 KW pump in the water treatment unit, because exists shift the limit switch on the pump's motorized valve

➢ *Calculation of Reject Losses*

- *Calculation of Reject losses on other pumps for calculations in January 2023*

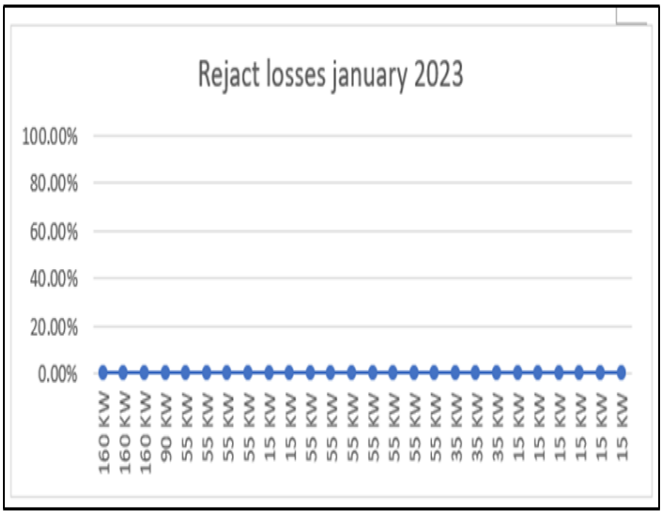

Fig 9 Calculation of Reject Losses on Other Pumps for Calculations in January 2023

ISSN No:-2456-2165

- *Calculation of Reject Losses on Other Pumps for February 2023 Calculations*

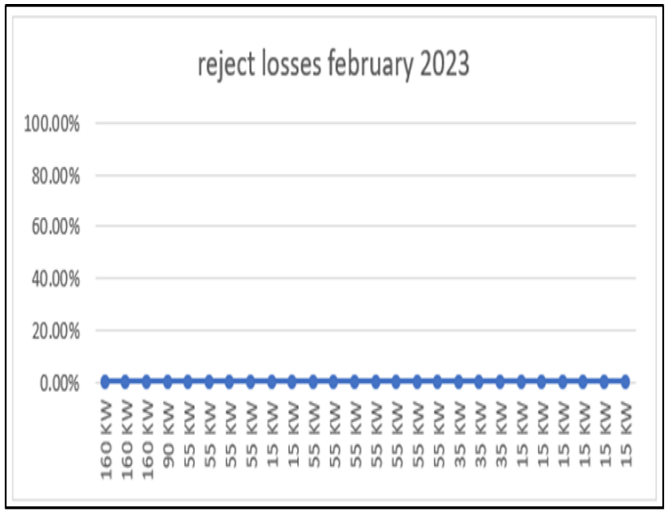

Fig 10 Calculation of Reject Losses on Other Pumps for February 2023 Calculations

- *Calculation of Reject Losses on Other Pumps for March 2023 Calculations*

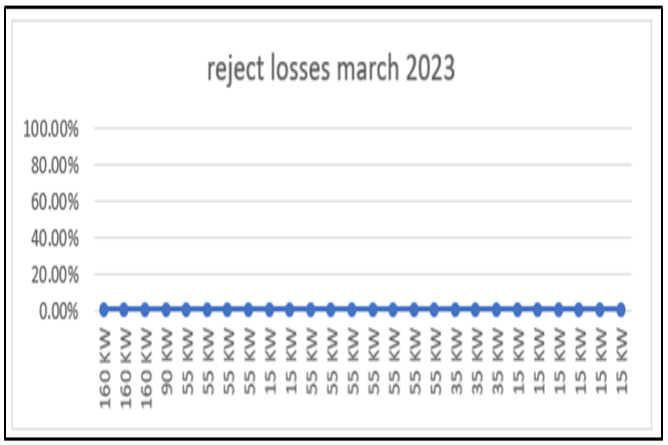

Fig 11 Calculation of Reject Losses on Other Pumps for March 2023 Calculations

- *Calculation of Reject Losses on Other Pumps for April 2023 Calculations*

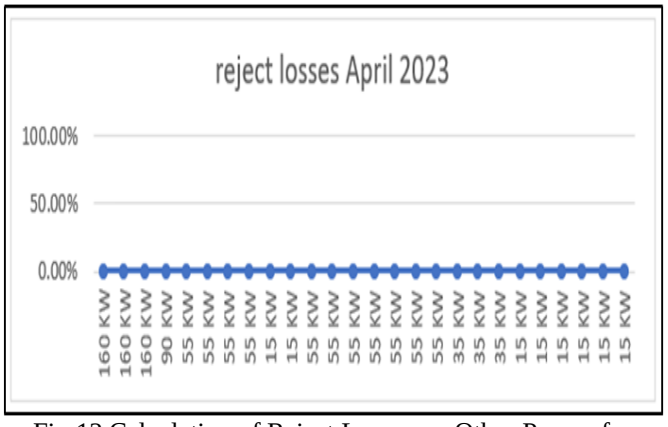

Fig 12 Calculation of Reject Losses on Other Pumps for April 2023 Calculations

- *Calculation of Reject Losses on Other Pumps for Calculations in May 2023*

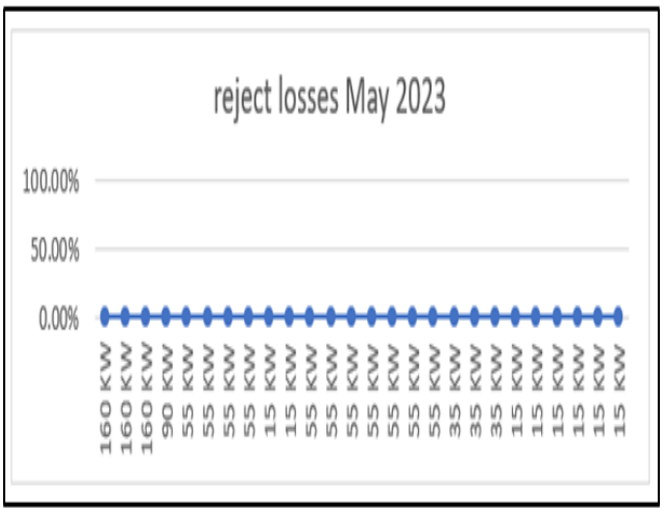

Fig 13 Calculation of Reject Losses on Other Pumps for Calculations in May 2023

- *Calculation of Reject Losses on Other Pumps for June 2023 Calculations*

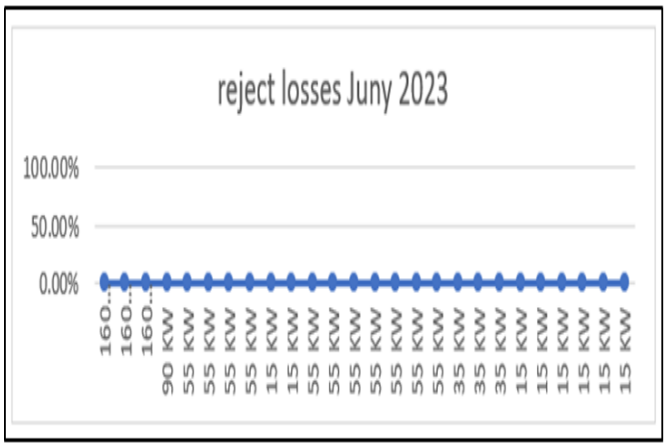

Fig 14 Calculation of Reject Losses on Other Pumps for June 2023 Calculations

- *Calculation of Reject Losses on Other Pumps for Calculations in July 2023*

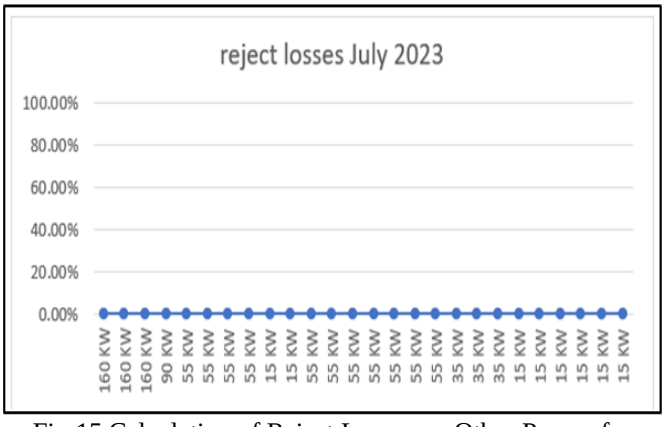

Fig 15 Calculation of Reject Losses on Other Pumps for Calculations in July 2023

B. Calculation of OEE Value

- *OEE calculations in this research will starting at 160 KW pump in January 2023.*

OEE = 86.73% x 98.11% x 95.56 % = 81.31%.

- *OEE calculations in this research will starting at 160 KW pump in February 2023.*

OEE = 87.08% x 98.27% x 96.57 % = 82.64%.

- *Calculation furthermore is OEE calculation in March 2023. OEE calculation in this research will be started calculations on 160 KW pump*

OEE = 85.54% x 90.97% x 98.73 % = 75.92%.

- *OEE calculations in this research will starting at 160 KW pumps in April 2023.*

OEE = 92.66% x 81.15% x 97.00% = 72.93%

- *The next calculation is the OEE calculation in May 2023.*

OEE calculations in this research will begin on a 160 KW pump in May 2023.

OEE = 72.45% x 92.38% x 97.75% = 65.42%

- *The next calculation is the OEE calculation in June 2023. The OEE calculation in this research will start on the 160 KW pump in June 2023.*

OEE = 82.14% x 92.69% x 96.56% = 73.52%

- *The next calculation is the OEE calculation in July 2023. The OEE calculation in this research will start on the 160 KW pump in July 2023.*

OEE = 85.15% x 99.71% x 92.48% =78.52%

V. DISCUSSION

- *Optimizing Preventive Maintenance on Main Distribution Centrifugal Pumps.*

- *Create and Implement Planned Maintenance*

An effective planned maintenance strategy involve development timetable routine maintenance, repairs or replacement components that have been reach the age limit use, and check periodically to detect potency problem before they develop become damage serious (Nusraningrum and Arifin, 2018).

Apart from that, companies that implement planned maintenance can also optimizing use source power and control cost maintenance more effectively. (Oroye et al., 2022). With know When equipment need checked or cared for, company can avoid action no maintenance need and allocate source Power wiser. Planned maintenance isn't it only reduce risk damage equipment, but also helpful increase efficiency operational and improving age use equipment, which in turn can support growth period long company. (Diwanda and Saldy, 2022) With apply appropriate care with SOP and manufacturing checklist maintenance so that makes it easier technician in do maintenance.

- *Make Inventory of Assets and Equipment*

Implementation of CMMS (Computerized Maintenance Management System) in inventory ethnic group spare become key in efficiency maintenance preventive and maintenance planned. CMMS makes it possible company to efficient manage inventory ethnic group spare parts, including critical equipment spare parts. CMMS can give real-time information regarding level supplies, usage ethnic group spare, and monitor age use component. With Thus, CMMS helps company in develop more effective maintenance strategies with ensure availability ethnic group the right spare at the right time.

- *Addition Operation & Maintenance Personnel*

By increasing pump operations and maintenance personnel, organizations can optimize their investments in infrastructure and equipment. Additional personnel can help maximize investment value through timely maintenance, efficient management, and increased pump life. Thus, additional personnel not only has an impact on operational reliability but also results in efficiency in managing company assets as a whole.

By referring to the FGD and background, the current technical personnel in the water treatment unit only have 7 personnel, whereas according to PT Angkasa Pura 2 directors' regulations number 0011, 2019, the need for personnel is 24 people, so this personnel need needs to be increased, taking into account the load. work carried out by this unit,

- *Implementing Tpm in Water Treatment Unit Centrifugal Pump Maintenance*

- *Implementing Autonomous Maintenance*

Autonomous maintenance is one of the TPM pillars that can be implemented, from FGD results with the water treatment team to implement this is necessary done, one of them with use distance monitoring system far as can be control and monitor every pumps this centrifuge. This program is a must running order every pump or every utilities in this unit can walk with good and can monitored, with apply RCMS system (Remote control management system). (Mulyati et al. 2022). With use this system then all constraint or damage to the pump can be detected in a way early and can dealt with in a way early.

- *System Maintenance Planned*

With exists a number of system that is already running Good from RCMS, CMOS and addition side OS and OM personnel then can done system maintenance planned with guided to SOPs and books existing guidelines (Ginste et al. 2022), currently as long as the RCMS has not can operate in a way the maximum this program can do executed manually with plan activity routine, good maintenance monthly, 3

monthly, 6 monthly and annually, with increase these personnel care stage 1 can planned and carried out with maximum. Unit leaders can plan this activity freely because condition personnel that have increased, and activities Field maintenance is also possible run by the OS team as well OM team with supervision power skilled and expert in carrying out activities can walk with good and appropriate plan (Al-refaie et al. 2022).

- *Training*

In implementing and running activity maintenance every personnel must given training Good in a way technical nor in a way management (Diwanda and Saldy, 2022), this is useful to support every plan in operate every activity care, in matter Water treatment unit personnel have received this training a number of training, among other things general K3 training, water pump system training, ISO 9001 training and several training management other, with exists activity These trainings are expected can assist and support the TPM implementation program in this unit (Prabowo et al. 2018).

- *Safety and Health Environment*

PT Angkasa Pura 2 in particular Soekarno Hatta Airport has implemented the related ISO 45001 with System Health and Safety Management Work, this point is very important in create culture healthy work and healthy environment, implementation System Health and Safety Management Work, also supports one of the pillars of TPM and becomes pioneer in implementing and implementing 5S (Mutaqiem et al. 2022), it is hoped with this application is possible implementing a healthy and environmental TPM program comfortable work as well as can carrying out company programs related to eco airports This can increase level efficiency use Power electricity and clean water (Syahrial and Nusraningrum, 2022).

- *Office TPM*

Implementing office TPM in water treatment units, in particular in context maintenance clean water booster pump, requires a specific and targeted approach to ensure constant availability of clean water and optimal quality. Initial step is conduct a thorough audit of the system booster pump, incl inspection condition physical, monitoring performance, and identification potency failure. This evaluation will help in understand condition operational nowadays, the need maintenance, as well as areas that require it attention specifically to improve efficiency and reliability. After do Identification and evaluation, step furthermore is design and implement timetable maintenance periodically for clean water booster pumps. This involves cleaning, inspecting, and replacing components that are worn or prone to failure. In addition, technical training for staff responsible for pump operation and maintenance should be provided to ensure that they have the knowledge and skills necessary to identify potential problems, perform routine maintenance, and respond to failures quickly and effectively.

- *Focused Maintenance*

The importance of focused maintenance in TPM is prevention problem before happen. With apply this approach in water treatment units, agencies can reduce downtime which is not planned, avoided failure equipment that can cause disturbance clean water supply, and ensure reliability operation period long. Through maintenance focused, the water treatment unit can increase efficiency, extend age use equipment, and ensure that safe and quality clean water supply can maintained with consistency.

- *Quality Maintenance*

To ensure Quality Maintenance effectiveness, important to develop cycle bait go back and evaluate periodically. This includes data collection, analysis performance, and identify areas of improvement potential. With adopt approach cycle Study sustainable, the water treatment unit can Keep going improve maintenance processes, implement innovation technology, and ensure that quality of clean water produced fulfil or surpass standard regulations and needs user. Through this approach, agencies can ensure safe, quality and reliable clean water supply for airport users served.

- *Development Management*

To ensure success implementation of development management in TPM, agencies must commit to regular evaluation and improvement sustainable. It's involving measurement performance, data analysis, and identification of areas of improvement potential. With utilise tools and techniques such as benchmarking, gap analysis, and periodic reviews, water treatment units can identify opportunities for improvement, introduce innovation technology, and ensure that maintenance clean water booster pump done with effective, efficient and fulfilling standard specified quality. Through Development Management approach, agency can strengthen capability organization, improve Skills employees, and achieve superiority operational in manage and maintain system critical booster pump for operation whole.

➢ *To Find out the Pillars of Effective TPM in Operate System Maintenance of Total Maintenance (TPM) on the Overall Equipment Effectives (OEE) of the Pump Centrifuges at the Water Treatment Unit at Soetta Airport.*

With condition like Currently there is no water treatment unit fully implement TPM in activity maintenance Good pump nor equipment other can seen from calculations in sub- chapter previously OEE value for centrifugal pumps Still is below 85 %. In the discussion in sub- chapter before and see results from the FGD of the TPM pillars that are very effective for the conditions currently in the water treatment unit is with implementing the pillars of autonomous maintenance, focused maintenance, creating planned maintenance and implementing quality maintenance to maintain pump pump existing centrifuges. _

In this discussion it must be done much more intense implementation of TPM from currently as has been done study previously by (Al- refaie et al. 2022) with do combination of TPM and TQM in treatment and research carried out by (Mutaqiem et al. 2022) that this research produces that TPM implementation provides contribution enhancement performance. Effect the is decline cost, increase quality, delivery smooth product, and improvement productivity. Implementing TPM is very important to

implement optimal use get Optimal results, the implementation of this TPM is expected like study previous that TPM implementation and all TPM pillars have influence positive to performance company. (Oroye et al., 2022), With implementation of this TPM can be done increase results quality of maintenance though OEE value is still below world OEE value. (Diwanda and Saldy, 2022)

VI. CONCLUSION

Based on results analysis and description results measurement of overall equipment effectiveness on the pump centrifuge , can answer existing problems in formulation problem, namely: optimizing preventive maintenance on pumps centrifugal distribution of clean water, Implementation of green TPM to improve quality maintenance pump centrifugal distribution of clean water , and the application of TPM in the Water Treatment unit is calculated with use overall equipment effectiveness method.

SUGGESTION

This centrifugal pump is a pump that is used as the main driver in the process of distributing clean water throughout the Soekarno Hatta airport area. This pump must be given optimal attention both in terms of mechanics, electricity and control instrumentation systems, taking into account the maintenance standards in SKEP 157, The preventive maintenance process must run well, and by implementing an autonomous maintenance system with a wider reach, making it easier for the technical team to monitor, monitor, ensure and carry out planned maintenance and focused maintenance well, so that the technical team can identify things that have potential early. disrupt operational activities at the pump in supplying clean water.

The author suggests that future researchers can develop research with a focus on implementing green TPM by using analysis of OEE calculations and six big losses by applying the green TPM design to all existing TPM pillars, as well as being able to develop inventory processes and spare parts data collection in carrying out maintenance activities on pumps. centrifuge.

REFERESCES

[1]. Adhiwikarta, Juju, Endi Haryanto, Susilo Hermawan, and Muhammadiyah Quality College of Technology. tt “PERFORMANCE ANALYSIS OF CNC WIRE CUTFANUC ROBOCUTα C400iB MACHINE USING OVERALL EQUIPMENT EFFECTIVENESS (OEE) METHOD AT PT. XYZ.”

[2]. Ahdiyat, Oleh Tatah, and Yohanes Anton Nugroho. 2022. "http://bajangjournal.com/index.php/JCI PERFORMANCE ANALYSIS OF BANDSAW MACHINE USING OVERALL EQUIPMENT EFFECTIVENESS (OEE) AND SIX BIG LOSSES METHOD AT PT QUARTINDO SEJATI FURNITAMA." JCI Scientific Horizon Journal. Vol. 2. http://bajangjournal.com/index.php/JCI.

[3]. Al-refaie, Abbas, Natalija Lepkova, and Mehmet Emre Camlibel. 2022. "The Relationships between the Pillars of TPM and TQM and Manufacturing Performance Using Structural Equation Modeling." Sustainability (Switzerland) 14(3). https://doi.org/10.3390/su14031497.

[4]. Alwi, Muhammad, Sualdi Zaynuddin, and Yumi Wonda. tt “IMPLEMENTATION OF TOTAL PRODUCTIVE MAINTENENCE (TPM) IN CRUSHER IX PT. BOSOWA MINIM MAROS.” http://jurnal.adpertisi.or.id/index.php/JNSTA/submissions.

[5]. “Analysis of the Application of Total Productive Maintenance as a Support for Productivity by Measuring the Overall Equipment Effectiveness at PT Sumalindo Lestari Jaya Global TBK 2022.” tt

[6]. Arga Tama, Viga, and Ayik Pusaka Ningwati. tt “ANALYSIS OF THE OCCURRENCE OF SIX BIG LOSSES ON THE EVAPORATOR MACHINE USING THE TPM METHOD IN THE MSG REFINERY SECTION OF PT. XXX.” http://jurnal.yudharta.ac.id/v2/index.php/jkie.

[7]. Arum, Oleh, Bella Adelia, and Ari Zaqi Al-Faritsy. 2022. “OVERALL EQUIPMENT EFFECTIVENESS (OEE) AND SIX SIGMA (CASE STUDY: PS MADUKISMO).” JCI Scientific Horizon Journal. Vol. 1. http://bajangjournal.com/index.php/JCI.

[8]. Bayesian, Journal, : Journal, Scientific Statistics, and Econometrics, Fatimah Sri Mulyati, Muhamad Taufik Septiadi, and Muchammad Fauzi. tt "ANALYSIS OF THE IMPLEMENTATION OF TOTAL PRODUCTIVE MAINTANANCE (TPM) USING THE OVERALL EQUIPMENT EFFECTIVENESS (OEE) METHOD AT PT XYZ." https://doi.org/10.46306/bay.v2i1.

[9]. Bhakti, Jasa, Naufal Muhammad, Rafi Fauzan, and Fahriza Nurul Azizah. tt “Effectiveness Analysis Using Overall Equipment Effectiveness Method in Identifying Six Big Losses on SY-GF 2500H Lathe (Case Study CV Analysis of the Effectiveness using Overall Equipment Effectiveness in Identifying Six Big Losses on SY-GF 250H Lathe (Case Study CV Jasa Bhakti).” https://doi.org/10.25124/jrsi.v9i01.501.

[10]. Cheng, Kaixin, Di Wu, Tao Hu, Jinjin Wei, and Zhifu Tian. 2022. “Cooperative Search Optimization of an Unknown Dynamic Target Based on the Modified TPM.” International Journal of Aerospace Engineering 2022. https://doi.org/10.1155/2022/8561245.

[11]. Daman, Agus, and Dewi Nusraningrum. 2020. “ANALYSIS OF OVERALL EQUIPMENT EFFECTIVENESS (OEE) ON HITACHI EXCAVATOR EX2500-6” 1 (6). https://doi.org/10.31933/DIJEMSS.

[12]. Diwanda, Fachri, and Tri Gamela Saldy. tt “Evaluation of the Capability of Loading Digging Equipment to Achieve Limestone Production Targets Using the Overall Equipment Effectiveness (OEE) Method at Bukit Karang Putih PT. Semen Padang.” Mining Development Journal 8 (1).

[13]. Dobra, Peter, and János Josvai. 2022. “Assembly Line Overall Equipment Effectiveness (OEE) Prediction from Human Estimation to Supervised Machine Learning.” Journal of Manufacturing and Materials Processing 6 (3). https://doi.org/10.3390/jmmp6030059.

[14]. Ginste, Lauren Van De, El Houssaine Aghezzaf, and Johannes Cottyn. 2022. “The role of equipment flexibility in Overall Equipment Effectiveness (OEE)-driven process improvement.” In Procedia CIRP, 107:289–94. Elsevier BV https://doi.org/10.1016/j.procir.2022.04.047.

[15]. Giuria-Farías, Angello, Camila Noriega-Revoredo, and Ernesto Altamirano-Flores. 2022. "Maintenance management model based on RCM and TPM to optimize times and costs within the useful life cycle of nautical assets." In Proceedings of the LACCEI international Multi-conference for Engineering, Education and Technology. Vol. 2022-July. Latin American and Caribbean Consortium of Engineering Institutions. https://doi.org/10.18687/LACCEI2022.1.1.747.

[16]. Gusniar, Iwan Nugraha, and Alfian Sidik. 2022. “TPM ANALYSIS OF AUTOMATIC CNC-CUTTER COURIER TEXTILE CUTTING MACHINE USING OEE METHOD AT PT. YIFAN JAYA.” Rang Engineering Journal 5(1): 56–60. https://doi.org/10.31869/rtj.v5i1.2733.

[17]. Haddad, Tamer, Basheer W. Shaheen, and István Németh. 2021. “Improving Overall Equipment Effectiveness (OEE) of Extrusion Machine Using Lean Manufacturing Approach.” Manufacturing Technology 21(1): 56–64. https://doi.org/10.21062/mft.2021.006.

[18]. Haryadi, Gunawan Dwi, Ismoyo Haryanto, IMW Ekaputra, Rando Tungga Dewa, and Deka Setyawan. 2022. "ANALYSIS OF CENTRIFUGAL PUMP IMPELLER STRUCTURE AND PERFORMANCE USING COMPUTATIONAL FLUID DYNAMIC AND FINITE ELEMENT METHOD." Journal of Mechanical Engineering 13(3): 773–86. https://doi.org/10.21776/jrm.v13i3.1199.

[19]. Ignatius, Kevin. 2022. “Total Productive Maintenance (TPM) in the Cardboard Production Process at PT. Superior Multipack.” Titra Journal. Vol. 10.

[20]. Klimecka-Tatar, Dorota, and Manuela Ingaldi. 2022. “Digitization of processes in manufacturing SMEs - Value stream mapping and OEE analysis.” In Procedia Computer Science, 200:660–68. Elsevier BV https://doi.org/10.1016/j.procs.2022.01.264.

[21]. Kurniawan, Ahmad, : Characteristics and Centrifugal Pumps. tt "CHARACTERISTICS OF CENTRIFUGAL PUMP WITH VARIATIONS IN ADDITION TO THE NUMBER OF FINS ON SEMI OPEN TYPE BLADES."

[22]. Lina Purnamasingrum, Dessi, Ahmad Fuad Afdhal, Master of Pharmaceutical Sciences, Faculty of Pharmacy, Pancasila University, and South Jakarta. 2023. "Analysis Of Overall Equipment Effectiveness (Oee) In Determining Productivity In Semi Automatic Semi Solid Filling Machines At PT Eduhealth Journal 14 (01): 2023. http://ejournal.seaninstitute.or.id/index.php/healt.

[23]. Mbaebie, Pius, Barinyima Nkoi, and Elemchukwu O Isaac. tt “Overall Equipment Effectiveness (OEE) and Reliability Analysis of the Water Supply Systems in Bonny Island.” International Journal of Engineering and Modern Technology. https://doi.org/10.56201/ijemt.

[24]. Meidya Qatrunada, Puteri, Dhiani Dyahjatmayanti, Air Transport Management, College and Aerospace Technology Yogyakarta. 2022. "ANALYSIS OF THE IMPLEMENTATION OF DIGITALIZATION OF PURA KARGO (TERKA) SPACE SERVICES ON AIR CARGO SHIPPING MOBILITY DURING THE COVID-19 PANDEMIC AT SOEKARNO-HATTA TANGERANG INTERNATIONAL AIRPORT." Journal of Citizenship 6 (1).

[25]. Mutaqiem, Agus, Dwi Soediantono, and the Naval Command and Staff College. 2022. “Literature Review of Total Productive Maintenance (TPM) and Recommendations for Application in the Defense Industries.” Journal of Industrial Engineering & Management Research. Vol. 3. http://www.jiemar.org.

[26]. Novianti, Salsabila, and Lilis Sulistyorini. tt "OVERVIEW OF PROCESSING RAW WATER INTO DRINKING WATER IN THE WELL OF PDAM X." http://journal.stikeskendal.ac.id/index.php/PSKM.

[27]. Nusraningrum, D, and Z Arifin. 2018. "Analysis of Overall Equipment Effectiveness (OEE) on Engine Power Plant Performance." KnE Social Sciences 3 (10). https://doi.org/10.18502/kss.v3i10.3468.

[28]. Nusraningrum, Dewi, and Edvan Gana Senjaya. 2019. "Over all Equipment Effectiveness (OEE) Measurement Analysis on Gas Power Plant with Analysis of Six Big Losses." www.ijbmm.com International Journal of Business Marketing and Management. Vol. 4. www.ijbmm.com.

[29]. Nusraningrum, Dewi, and Lysa Setyaningrum. 2019. “Overall Equipment Effectiveness (OEE) Measurement Analysis for Optimizing Smelter Machinery.” www.ijbmm.com International Journal of Business Marketing and Management. Vol. 4. www.ijbmm.com.

[30]. Oloan Purba, Fader, and Elva Susanti. 2022. "ANALYSIS OF THE IMPLEMENTATION OF TOTAL PRODUCTIVE MAINTENANCE (TPM) ON CNC DRILLING MACHINES AT PT AMTEK PRECISION COMPONENTS BATAM." COMASIE JOURNAL.

[31]. Oroye, Olufemi Adebayo, Bamisaye Olufemi Sylvester, and Peter Kayode Farayibi. 2022. "Total productive maintenance and company performance: a case study of fast moving consumer goods companies." Journal of Industrial Systems and Management 6(1): 23–32. https://doi.org/10.30656/jsmi.v6i1.4185.

[32]. Pardamean Sibuea, Hotman. 2022. "IMPLEMENTATION OF TOTAL PRODUCTIVE MAINTENANCE USING THE OVERALL EQUIPMENT EFFECTIVENESS (OEE) METHOD AT PT MECHMAR JAYA INDUSTRI." Journal of Engineering Management and Business Innovation. Vol. 1. https://journal.iteba.ac.id/index.php/journalenterprise.

[33]. Prabowo, Herry Agung, Yudha Bobby Suprapto, and Farida Farida. 2018. "THE EVALUATION OF EIGHT PILLARS TOTAL PRODUCTIVE MAINTENANCE (TPM) IMPLEMENTATION AND THEIR IMPACT ON OVERALL EQUIPMENT EFFECTIVENESS (OEE) AND WASTE." SYNERGY 22(1): 13. https://doi.org/10.22441/sinergi.2018.1.003.

[34]. Priyono, Sigit, Machfud Machfud, and Agus Maulana. 2019. "Implementation of Total Productive Maintenance (TPM) at a Refined Sugar Factory in Indonesia (Case Study: PT. Journal of Business and Management Applications, May. https://doi.org/10.17358/jabm.5.2.265.

[35]. Ridwansyah, M, Dewi Nusraningrum, and Ahmad H Sutawijaya. tt "ANALYSIS OF OVERALL EQUIPMENT EFFECTIVENESS TO CONTROL SIX BIG LOSSES ON NUGGET MANUFACTURING MACHINERY."

[36]. Rifky Zulfikar, Muhammad, Aufa Nurfathi Rizqullah, Eka Samudra Pratama, Selvi Febrianti, Fadillah Al Azhar, and Asep Anwar. 2022. "Analysis of Total Productive Maintenance (TPM) Using Overall Equipment Effectiveness (OEE) Approach on Cartoner Machine at PT. A B C." Vol. 12.

[37]. Risonarta, Victor Yuardi, and Angelia Kusuma Wardhani. 2023. "INCREASING PROFITABILITY OF A MANUFACTURING COMPANY BY USING THE TOTAL PRODUCTIVE MAINTENANCE APPROACH: A REVIEW." International Journal of Mechanical Engineering Technologies and Applications 4(1): 39–50. https://doi.org/10.21776/MECHTA.2023.004.01.5.

[38]. Rosario Lopez, Ayechia M, and Rolando Nigaglioni. tt "Total Productive Maintenance (TPM) to Improve Laboratory Performance."

[39]. Šajdlerová, Ivana, Vladimíra Schindlerová, and Jiří Kratochvíl. 2020. "Potential and Limits of Overall Equipment Effectiveness in the Total Productivity Management." Advances in Science and Technology Research Journal 14(2): 19–26. https://doi.org/10.12913/22998624/113617.

[40]. Satria, Shandy, Wangsa Putra, and Berty Dwi Rahmawati. tt "Raw Mill Machine Effectiveness Measurement through the Total Productive Maintenance (TPM) Implementation Measuring the Effectiveness of Raw Mill Machines through the Implementation of Total Productive Maintenance (TPM)." https://doi.org/10.31315/opsi.v15i2.7729.

[41]. Solikhah, Pristiyani, and Dewi Nusraningrum. 2022. "Increasing Production Capacity of Oil Country Tubular Goods Pipe Using Oee Methods." European Journal of Business and Management Research 7 (5): 9–14. https://doi.org/10.24018/ejbmr.2022.7.5.1612.

[42]. Suseno, Oleh, and Angga Prasetya Aji. 2022. "ANALYSIS OF PRODUCTIVITY OF ASSP MANUFACTURING MACHINERY USING OVERAL EQUIPMENT EFFECTIVENESS (OEE) AND FAILURE MODE AND EFFECT ANALYSIS (FMEA) METHOD AT PT MERAPI MEDIKA SOLUSINDO." JCI Scientific Horizon Journal. Vol. 1. http://bajangjournal.com/index.php/JCI.

[43]. Syahrial, Teuku Riza, and Dewi Nusraningrum. 2022. "Improving Performance and Electricity Production with the Overall Equipment Effectiveness Method as the Basis for the Proposed Application of the Total Productive Maintenance Concept on the PLTS Equipment System at Soekarno-Hatta Airport." European Journal of Business and Management Research 7(4): 378–84. https://doi.org/10.24018/ejbmr.2022.7.4.1603.

[44]. Tafana, Tiara, Nurmala Hamzah, and Ade Momon. 2023. "Analysis of Total Productive Maintenance Using the Overall Equipment Effectiveness Method on the New 2500T Injection Machine at PT. XYZ" VIII (1).

[45]. Wiyatno, Tri Ngudi, and Hibarkah Kurnia. tt "Increasing Overall Equipment Effectiveness in the Computer Numerical Control Lathe Machines Using the Total Productive Maintenance Approach Increasing Overall Equipment Effectiveness on Computer Numerical Control Lathe Machines Using the Total Productive Maintenance Approach." https://doi.org/10.31315/opsi.v15i2.7284.