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Optimization of Overall Performance Industrial System Water / WTP in Taman Niaga Karawang Prima Industrial Area

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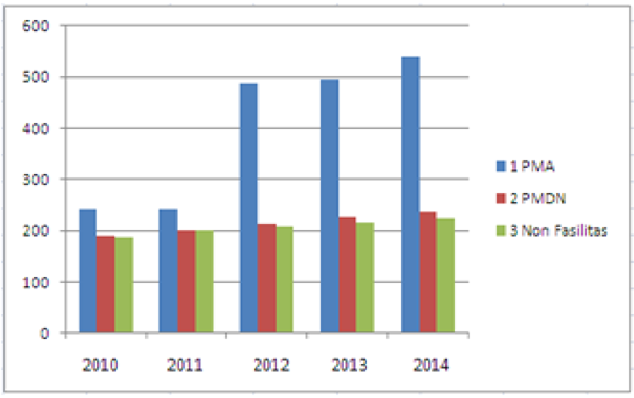
Abstract:- The development of industrial estates in Indonesia is increasingly rapid, especially the automotive industry and the like, starting to expand into the Asian region, one of which is Indonesia. For this reason, the authors conducted research in an industrial area of Taman Niaga Karawang Prima, located in West Java, Karawang by analyzing the process of water purification as one of the facilities provided for the operational needs of the factory itself, where the existing water treatment system still lacks in terms of performance and quantity of water provided, in this study the authors use quantitative data and descriptive exploratory analysis, the results of the improvements to be achieved are improvements in machine performance and changes in management governance.

***Keywords**:- Performance, Management Governance And Product Quantity.*

I. INTRODUCTION

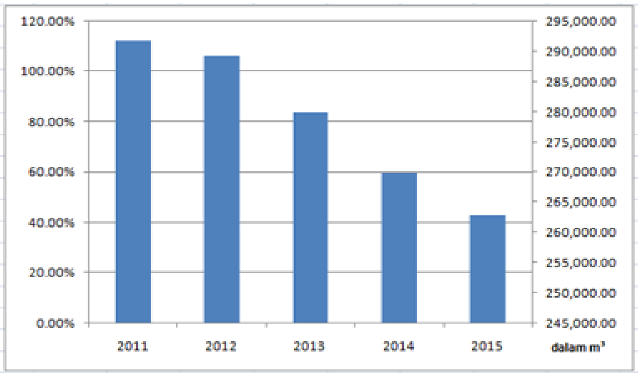
1.1 Background

The development of industrial estates in Indonesia has progressed rapidly since the AFTA was implemented which was formed during the 4th ASEAN Summit (Summit) in Singapore 1992 (Director General for ASEAN Cooperation, 2008) and put into effect in Indonesia in December 2015, in Indonesia the demand for land for industrial estates continues to increase along with the industrial downstream program and the increasing performance of the Indonesian economy, in the future Indonesia needs at least 10 thousand hectares of land for new industrial estates, the Ministry of Industry estimates that the need for industrial land in Indonesia will reach 1,2oo Ha in the next five years around 60 % of industrial development is still centered on the island of Java, especially in the province of West Java (data source: Investor Daily January 2012), as for the West Java area, industrial areas are focused on two areas, namely: Karawang Regency and Bekasi Regency.



Graph 1.1 Scale of Industrial Estate Development in Karawang

From the results of the study that an industrial area must have facilities and infrastructure, one of which is a Water Treatment Installation System to meet the needs for clean water in existing factories and the needs for employees, while still paying attention to the conditions of the surrounding environment, below will convey the need for clean water based on the type of industry in the Karawang Prima Industrial Park. The following is a graph of the production of water for the past 5 years which has decreased with the same equipment



Graph 1.2 data of clean water production for 5 years (in m³

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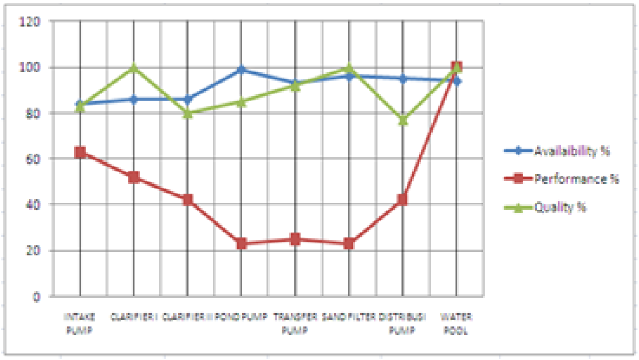
From the data data depicted in the graph above, there is an average decrease of up to 29% of the maximum capacity of the equipment which may be caused by technical and non-technical factors that can occur and to find out this can be seen from Graph 1.5 for Availabily, Performance and Quality below:



Graph 1.3 Value fluctuations in Availability, Performance and Quality

The value of the Overral Equipment Effectiveness decreased by 37%, whereas if a comparison is made with the standardized values, it is as follows:

Table 1.1 Value of tool capabilities

Equipment	Value of water purification facilities	World Class Value
Water Purification Facility / Water Treatment Plant	Availability 0.90	Availability 0.90
	Performance 0.46	Performance 0.95
	Quality 0.90	Quality 0.99
	OEE 0.37	**OEE 0.85**

1.2 Problem Formulation

Based on the background description above, the problem that occurs in the clean water treatment system is the inadequacy of good OEE so that it reduces the performance of the equipment itself, so the research carried out includes the following:

1. What are the causes of potential problems that occur that contribute to the low OEE value of the system?
2. How improvements are made so that the OEE value can be higher than the current OEE, as well as other supporting systems.

1.3 Research Objectives and Benefits

This activity aims to get a good result for the company and can also be used for further research where optimal product results can be produced with the following explanation:

1. By changing the existing methods and systems, it is hoped that the results of production and the system can be more optimal.
2. By analyzing each existing equipment, it is hoped that the existing OEE can be improved and can formulate what improvements should be made.

1.4 Problem Limitation

In conducting this analysis carried out at the Industrial Estate Management company, namely PT Tirta Bumi Dwikarya which manages the Karawang Prima Industrial Park, by conducting an analysis of water purification equipment / Water Tretment Plant which includes:

1. Analyzing the system procedures carried out in order to know existing work patterns so that the speed between the flow of information and goods can be balanced.
2. Inventory of existing equipment consisting of all water purification equipment systems, as well as calculating the performance of these equipment.

The things mentioned above are absolutely necessary to design strategic formulas so that customer satisfaction can be met, productivity and efficiency of time, material and other resources are optimal.

II.LITERATURE REVIEW

Water is all water that is above or below the surface of the ground, including in this definition is surface water, ground water, rainwater and sea water on land which can be seen in the Law on Water Resources No.7 of 2004 article 1, (kodoati 2005).

In its definition, the need for clean water can be divided into two, namely:

1. *Domestic Water Needs*

Domestic water needs can be categorized as household needs, religious facilities, public facilities, social facilities and government offices.

2. *Non Domestic Water Needs*

Non-domestic water needs are usually used for industrial needs with a scale ranging from light industry to heavy industry.

2.1 Water Purification Work Pattern Cycle

In the implementation of the water purification installation work system currently in Figure 2.2 below:

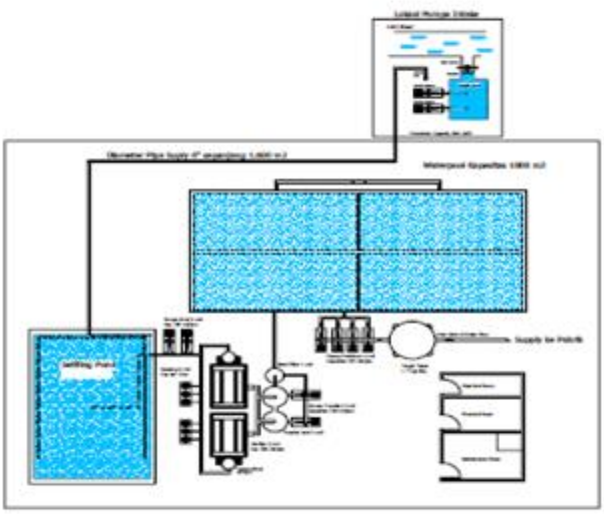


Figure 2.1 clean water treatment plant system

1. *Intake Pump*

Existing river water is made a flow through a channel that enters the intake pump area which is then deposited in a settling basin with a rectangular 3 x 3 x 3 shape

2. *Settling Pond*

The water that has been deposited in the intake pump is then accommodated by the Settling Pond

3. *Pond Pump*

The water that has been deposited will then be pumped which is then sent to the Clarifier tower which functions as a mixing place.

4. *Clarifier Tower*

Is a tower that is rectangular and at the bottom of the cone which functions as a gathering place for water that has been bonded with chemicals,

5. *Dossing Pump*

The function of a dosing pump is to pump existing chemicals with a capacity of 1 liter to 100 liters of water

6. *Sand Filter*

Water that is clean and clear in the clarifier that has gone through the coagulation process will then flow overflow because it is pressed by water that is bound to chemicals found at the bottom of the clarifier tub.

7. *Transfer Pump*

The water that falls to the bottom of the sand filter tank will then be flowed by the transfer pump to the final reservoir which is commonly referred to as a water pool.

8. *Water Pool*

It is a water collection building with a capacity of 1000 m^3

9. *Distibution Pump*

Is a pump that functions to drain water from the water pool to each consumer with an automatic system

III. RESEARCH METHODOLOGY

The purpose of this research is to determine the factors causing the failure of the water purification system / WTP to facilitate solving the problems faced, it is necessary to describe in advance the steps needed to solve these problems and the time required for this research takes 6 months to start. June 2016 to December 2016. The stages carried out are described in table 3.1 below:

Table 3.1 Research Variables

Variable	Dimensions	Indicator
Implementation of TPM	Realibility	Availability Performance Availability
System Optimization	Breakdown system	Level of problem Repair deadline The time it happened
Support system	Potential Problems	Man Power Machine Measure Method Material

3.1 Analysis with Fishbone Diagram

by analyzing the fishbone diagram where in the fishbonne diagram solving the problem d is divided into 5 variables, namely mapping the problem to 5 main variables, namely:

Table 3.2 Categories and problems that arise

Category	Description
Man Power	Human resources are a potential cause of problems or not, whether they meet the required standards and knowledge of existing equipment.
Material	material as raw material or as spare parts needed to replace scarce spare parts from one of the materials needed can hinder reliability
Method	The combination of work standards is a standard that is carried out by employees, especially operators
Machine	the level of production quality requirements can also be influenced by the availability of existing machines, whether the machines currently used are in accordance with specifications
Measure	A work record based on technical data is adjusted to the actual conditions while the equipment is operating
Environment	In addition, whether the waste generated is properly managed or not.

As well as opinion gathering in a brainstroming session which was attended by 7 teams consisting of a supervisor, head of the area, head of the team, and 2 senior members of the operator.

3.2 Analysis of Overal Equipment Effectiveness

The data analysis process begins by reviewing all available data from various sources, calculating with the OEE (Overal Equipment Effectiveness) method based on existing data in the clean water production section in the monthly reports, data on the value of Availability, Performance and Quality are obtained.

$$\text{Availability} = \frac{\text{Operating Time} - \text{Downtime}}{\text{Operating Time}}$$

$$\text{Performance} = \frac{\text{Process Amount} \times \text{The Priority Cycle Time}}{\text{Operating Time}}$$

$$\text{Quality} = \frac{\text{Process Amount} - \text{Defect Amount}}{\text{Process Amount}}$$

$$\text{OEE} = \text{Availability} \times \text{Performance} \times \text{Quality}$$

3.3 Method 5 Why Analysis

This method is used to trace the data why the water purification system is not optimizing so that potential problems that occur from different sides can be identified. The questions posed are of course still in the vicinity of the system being analyzed by asking the operators and supervisors with each level held by each level of position. The sample questions are as follows:

Table 3.3 Analysis with 5 Why Analysis

Why 1	Rev 2	Rev 3	Rev 4	Rev 5
System failure occurs in the water purification unit	Because the operational system has a shortage	The operational system involves several interrelated matters	Due to management's own policies	All of this is related to the existing costs of the shareholders

3.4 Fault Tree Analysis

Fault Tree Analysis is used to identify potential problems that occur in this water purification system, the goal is to find out the main problem and find the root of the problem starting from the production produced to the initial water distribution system starting from raw water to clean water. generated.

IV.DATA AND ANALYSIS

4.1Data collection stage

Based on the preliminary research data that has been presented in chapter 1, there has been an inoption in the water purification system, especially in the area of the intake pump and other supporting pumps which resulted in the work of the water purification system / WTP not working optimally in producing output in the form of the number of clean water events analyzed. This has been happening for the past 5 years starting from 2011 to 2016 where the graph of clean water production has continued to decline while the electricity used has a fixed value.

4.2 Chronology of system optimizations

In every production of clean water by this system, it is always recorded in the work report data the amount of output from the production, namely in the form of clean water which is measured in cubic units, some things that are potential contributors to the problem are as follows:

a. The distribution of electricity (Energy supply) has experienced losses of 11%, which should have been stable at the start of the electric motor, but because of the power surge so that the existing cable could not hold the power, the result was the voltage drop from 390 to 350 volts.
b. The effect of the lack of power that results in production cannot be as desired. It is expected that the pump can drain 360 m of water³/ hour but only able to output 300 m³/ hour or 20% losses.
c. The water that is distributed to the setling pond storage reservoir as the initial deposition is not as much as the dimensions of the reservoir built so that there is a large enough space left, so this contributes to ineffective land use.
d. Furthermore, the water will be sucked back by the pond pump according to existing data, the pump capacity has also decreased from a capacity of 130 m³/ hour it turns out that the resulting output is 110 m³/ hour here there is also a loss of 18%.
e. Water that has been sucked in by the pond pump will enter the clarifier which will then undergo a coagulation process which should allow the clarifier to operate for 250 m³/ hour but it turns out that the resulting output is only capable of 200 m³/ hour here there is lesses of 20%.
f. Likewise, the distribution and transfer pumps experienced a loss of 30% and 8%, respectively.

4.3 Problem identification

From several things presented at the point above, the existing problems have been identified, namely:

a. There are losses in the water purification system where the output produced is not as desired, namely the intake pump, pond pump, and distribution pump as well as transfer to the clarifier.
b. There was a decrease in performance which was the result of several things, namely management policies in making SOPs, an orderly work culture, absence of accurate reports on the conditions of existing equipment.

4.4 Problem Analysis

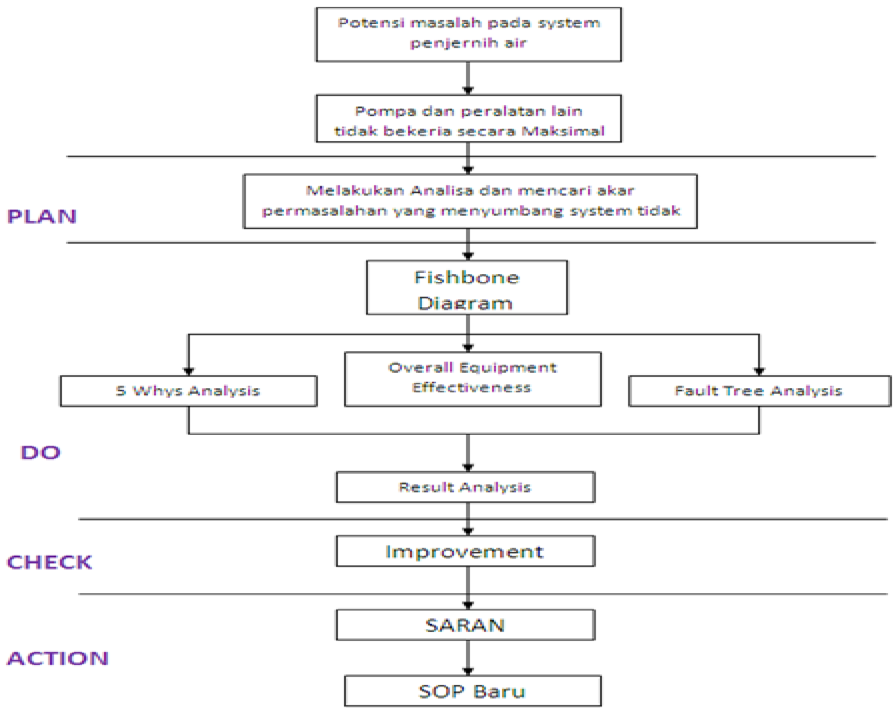


Figure 4.1 Problem solving flowchart

From the existing problem surgery flowchart, it can be seen that the sequence of steps taken in solving an existing problem is as follows:

4.5 Fishbone Diagram Method

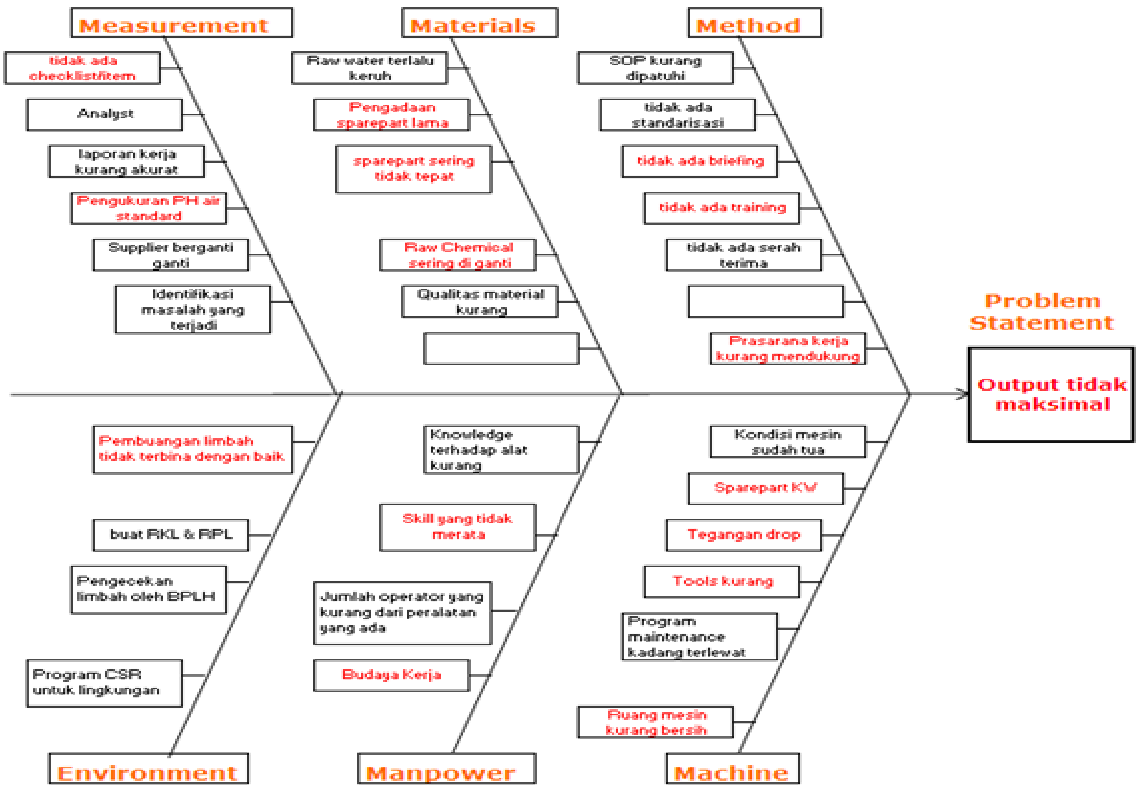


Figure 4.2 Fishbone Diagram

Analysis using the fishbone method by classifying categories, namely: Man, Material, Measure, Methods, Machine and Environment, it can be concluded that several categories contribute to potential problems so that answers to existing problems must be sought so that potential problems that occur can be minimized or eliminated.

Table 4.1 problem solving for the category side

Potential Problems: **Output is not optimal**	
Category	**Recommendations proposed**
Measurement: ***There is no equipment checklist*** ***Standard water PH measurement***	There is no valid data record, it is necessary to make an equipment checklist form. The tool used to measure the PH content of water is still standard, so it requires high accuracy, so digital water meters can be used such as: Multiparameter Lutron PH-208 PH Meter Requests to fulfill the need for replacement of spare parts often take a long time for the function of these parts support for a tool to move optimally.
Material: ***Procurement of old spare parts*** ***Nominations for spare parts are often incorrect*** ***A raw chemical that is changed frequently***	Sometimes the part numbers are the same but the goods are of different quality. For an indication of the bearing part numbers, see the manual book Chemicals that change frequently cannot guarantee good quality,
Machine: ***Spare Parts Kw*** ***Voltage drop*** ***Less Tools*** ***The engine room is not clean enough***	The problem of improper spare parts and item number 2 or KW is an absolute thing that must be eliminated because it affects the running system. Decreasing performance, the solution is to install a voltage Step Up transformer with a recommendation from the PLN Department. Work facilities that are less supportive have made repairs take a long time It can be seen that many employees do not undergo the 5S so that the work environment is not good
Man Power: ***Uneven skill*** ***Work culture***	Basic knowledge of an equipment in an installation is absolutely necessary for the uneven skill ability The lack of discipline is very evident on the operator side. The standard work uniform is often not used
Enviroment: ***Waste disposal is not properly maintained***	This is very dangerous for this system itself if it is not properly maintained, so if a sudden inspection from the BPLH Office is seen, if the waste is dumped carelessly, it can be subject to license revocation.
Mehods: ***There is no briefing*** ***No training*** ***Less working tools***	briefings should be conducted at the start of each shift. Job training needs to be done to keep up with increasingly advanced equipment fulfillment of work facilities or assistive devices must be done and a checklist is made

4.6 Overall Equipment Effectiveness Method

By using the OEE method, it can be seen that the existing system shows that the production data for 5 years from 2011 to 2015 has experienced losses so that the production graph continues to decline, this decrease has a spread value of 29% of normal capacity so that improvement steps must be taken so that The resulting OEE could increase to close to 85%,

The proposed improvements are as follows:

1. Fixing an existing voltage source where the current voltage is 350 volts as for the standard requirements for the motor drive so that it can operate according to the data of 390 volts, the way to improve the voltage is to install a step up transformer so that voltage loss can be reduced and the output of the pump can be maximized.
2. Replacing parts with original parts such as (bearings, gland packing, etc.)
3. Installing work aids such as tackles, hydraulic trackers, etc. as shown in the picture… ..
4. Make an equipment checklist for all equipment, both the main or only work support facilities as in the table….

Below is the calculation to find the actual OEE value using the formula for Availability, Performance and Quality, which can then be seen how much OEE value the existing equipment has, as follows:

Pompa Distribusi

$$\text{Availability} = \frac{\text{Operating Time - Downtime}}{\text{Operating Time}} = \frac{480 - (20 + 5)}{480} = \mathbf{0{,}94}$$

$$\text{Performance} = \frac{\text{Pocess Amount x Theoritas Cycle Time}}{\text{Operating Time}} = \frac{100 \times 1}{480} = \mathbf{0{,}20}$$

$$\text{Quality} = \frac{\text{Process Amount - Defect Amount}}{\text{Process Amount}} = \frac{130 - 30}{130} = \mathbf{0{,}76}$$

Waterpool

$$\text{Availability} = \frac{\text{Operating Time - Downtime}}{\text{Operating Time}} = \frac{480 - (30 + 0)}{480} = \mathbf{0{,}93}$$

$$\text{Performance} = \frac{\text{Pocess Amount x Theoritas Cycle Time}}{\text{Operating Time}} = \frac{1000 \times 1}{480} = \mathbf{2{,}00}$$

$$\text{Quality} = \frac{\text{Process Amount - Defect Amount}}{\text{Process Amount}} = \frac{1000 - 0}{1000} = \mathbf{1{,}00}$$

Pompa Pond

$$\text{Availability} = \frac{\text{Operating Time - Downtime}}{\text{Operating Time}} = \frac{480 - (45 + 10)}{480} = \mathbf{0{,}89}$$

$$\text{Performance} = \frac{\text{Pocess Amount x Theoritas Cycle Time}}{\text{Operating Time}} = \frac{110 \times 1}{480} = \mathbf{0{,}23}$$

$$\text{Quality} = \frac{\text{Process Amount - Defect Amount}}{\text{Process Amount}} = \frac{130 - 20}{130} = \mathbf{0{,}85}$$

Sand Filter

$$\text{Availability} = \frac{\text{Operating Time - Downtime}}{\text{Operating Time}} = \frac{480 - (20 + 0)}{480} = \mathbf{0{,}95}$$

$$\text{Performance} = \frac{\text{Pocess Amount x Theoritas Cycle Time}}{\text{Operating Time}} = \frac{54 \times 1}{480} = \mathbf{0{,}11}$$

$$\text{Quality} = \frac{\text{Process Amount - Defect Amount}}{\text{Process Amount}} = \frac{54 - 0}{54} = \mathbf{1{,}00}$$

Clarifier 1

$$\text{Availability} = \frac{\text{Operating Time - Downtime}}{\text{Operating Time}}$$

$$= \frac{480 - (60 + 5)}{480}$$

$$= \mathbf{0{,}86}$$

$$\text{Performance} = \frac{\text{Pocess Amount x Theoritas Cycle Time}}{\text{Operating Time}}$$

$$= \frac{250 \times 1}{480}$$

$$= \mathbf{0{,}52}$$

$$\text{Quality} = \frac{\text{Process Amount - Defect Amount}}{\text{Process Amount}}$$

$$= \frac{250 - 0}{250}$$

$$= \mathbf{1{,}00}$$

Clarifier 1

$$\text{Availability} = \frac{\text{Operating Time - Downtime}}{\text{Operating Time}}$$

$$= \frac{480 - (60 + 5)}{480}$$

$$= \mathbf{0{,}86}$$

$$\text{Performance} = \frac{\text{Pocess Amount x Theoritas Cycle Time}}{\text{Operating Time}}$$

$$= \frac{200 \times 1}{480}$$

$$= \mathbf{0{,}42}$$

$$\text{Quality} = \frac{\text{Process Amount - Defect Amount}}{\text{Process Amount}}$$

$$= \frac{250 - 50}{250}$$

$$= \mathbf{0{,}80}$$

From the results of the analysis by calculating the existing values, the actual OEE value is 37%.

4.7 Method 5 Why Analysis

By using the 5 why analysis method, it can be seen that this system is not optimal because it is caused as follows:

Table 4.2 Conclusions from the 5 why analysis

Causes of Problems	**Improvement that must be made**
The pump cannot work optimally in producing the output according to the plan due to several factors, namely, the voltage received by the pump drops because the distance is too far up to 1600 meters from the location.	The current electric power only has a voltage of 350V, where the voltage that the pump should need is 380 Volts to 390 volts, this affects the rotation of the rotor of the electric motor that drives the pump so that the rotation is interrupted due to the voltage, the resulting output is also reduced. The distance that is too far also affects the electric voltage which drops by up to 11% to overcome this, a Step Up Transformer can be installed at the location of the intake pump so that the existing distance will be close to a power source. When replacing parts, quality goods or number 1 must be taken into account when unloading the existing parts and when replacing them, you must use a 5 ton tackle to lift a heavy pump. And use a long pipe when opening the bearing with the tracker
Procurement of improper part replacement and improper repair work patterns due to insufficient work facilities.	For the procurement of goods, it is better if 1 supplier is appointed and a cooperation agreement is made regarding the speed of supplying the required parts, quality assurance, and the agreed price will not fluctuate within a certain period of time by making an agreement and legalized in the notary office in order to get certainty and legally binding for a certain period of time, For example 1 year or depending on the dollar rate used as reference
In the procurement of parts, especially fast moving, comparisons are always carried out so that it is difficult to get quality goods.	

4.8 Analysis with Fault Tree Analysis

By using a fault tree analysis of existing problems try to group them and the results will be conical and will produce problem formulations that become potential problems from existing problems. Based on solving the problem with a mapping system on the fault tree analysis, it can be concluded that the shape of the tree diagram is:

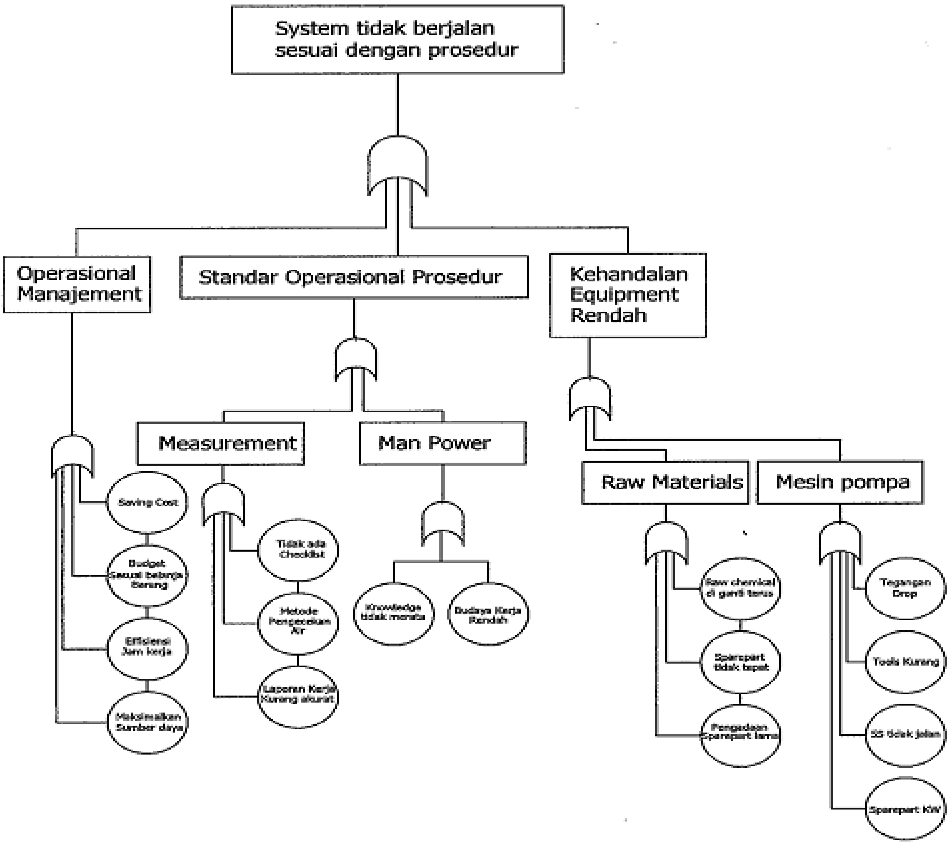


Figure 4.3 Problem solving with Fault Tree Analysis

From solving potential problems with the FTA method, it can be seen that the causes that make the system not optimal are as follows:

1. *Operational management which is decided by the top leadership*

Resulted from the position of a company that wants to play it safe by saving operational budgets, both for the work implementation system and the procurement of material needs.

2. *Operational standards that are carried out are adjusted to the location*

The pattern of work application is not optimal due to a lack of manpower so that several programs cannot be implemented which indicates the quality of work produced.

3. *Low Equipment Reliability*

The low level of reliability is contributed by the poor condition of the supporting system, such as the voltage that always drops and has no solution, raw materials that always change the impact of management policies in making savings, and the existing 5S program is not running.

From several methods using the tool, the results can be concluded and are known so that then a corrective step can be taken by making changes / improvements as follows:

❖ *Improvement made*

➢ *Before Improvement*

The work method used is high creativity but unfortunately it is not accompanied by good knowledge so that sometimes the results of creativity carried out on one side make the condition of the equipment in a dangerous situation for the operator himself.

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➢ *After Improvement*

Safety factors for people and machines are still considered for the case on this machine, so repairs must be made by replacing them with original parts, given the position of these parts in a vital place.

To simplify the engine repair pattern, work aids are needed, for the procurement of Chain Block with a capacity of up to 2 tons it is necessary to lift the intake pump which has a weight of 700 Kg, during routine maintenance processes or during downtime for some reason.

➢ *Before Improvement*

Before the lat Chain Block was held, the operators replaced one of the parts in the pump machine to lift the machine manually and required a workforce of 7 people.

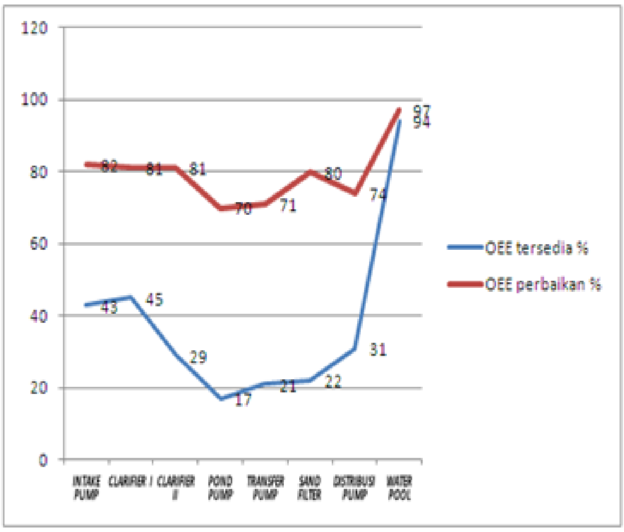
➢ *After Improvement*

After the improvement is done, the replacement part on the machine only requires 3 workers so that it can save 4 workers and the repair time is short.

No	Uraian	data Electrical				Keterangan
		Voltage	Amphere			
			R	S	T	
1	Electrical					
		Indicator				
	Panel kontrol	Baik		Aus		
1	Kondisi pintu panel					
2	Lampu lampu Indicator					
3	Kondisi amphere meter					
4	selector switch					
5	kondisi kontactor					
6	konndisi relay relay					
7	scun kabel					
8	Breaker Induk					
9	MCB pembagi					
	Motor listrik					
1	body mesin					
2	baut body					
3	kipas pendingin					
4	pengman kipas pendingin					
5	grease bearing depan					
6	grease bearing belakang					
7	join kople					
8	karet joint kople					
9	engine mounting					
10	cover kople					
	Pompa					
1	Bodi pompa					
2	Gland packing					
3	Baut gland packing					
4	baut body					
5	pump mounting					
6	presseure gauge					
7	check valve					
8	gate valve					
9	Flexible joint					

Table of proposed Equipment Checklist Form

It is hoped that by taking these steps, performance improvements will be obtained and will improve the existing OEE value so that it can approach the OEE which is the standard of the industry.



No	Pompa	Sebelum	Sesudah
1	Intake Pump	0.43	0.82
2	Clarifier 1	0.45	0.81
3	Clarifier 2	0.29	0.81
4	Pond Pump	0.17	0.7
5	Transfer Pump	0.21	0.71
6	Sand Filter	0.22	0.8
7	Distribution Pump	0.31	0.74
8	Waterpool	0.94	0.97
	Hasil	0.37	0.79

OEE data after OEE enhancement Graph Repair

V. CONCLUSIONS AND RECOMMENDATIONS

➢ *Conclusion.*

Based on the results of research in the previous chapter, the following conclusions can be drawn:

1. Factors that contribute to the not optimal water purification system and need to be studied are:
   a. Voltage received is not suitable or Drop
   b. It took a long time to procure spare parts
   c. There is no briefing at the start of work and Skill training
   d. Lack of work support facilities
   e. There is no equipment checklist form
   f. 5s program not running
   g. Lack of information for Top Management.

2. The improvements were made by analyzing based on the following data:
   a. Propose to install a Step Up Transformer at the location of the intake pump.
   b. Conduct a tender system for suppliers as a single-term supplier agent by making an MOU
   c. Menng recommending a briefing at the start of work
   d. Emphasize that the SOP is implemented
   e. Installing work support facilities as in Figure 4.5, namely the lifting equipment (Tackle)
   f. Create a checklist form as shown in Figure 4.8 and run it with the knowledge of the local manager.
   g. Cultivate 5S so that it goes back
   h. Create reports in PPT format with work report attachments.

The results of the analysis carried out and if applied will improve the existing OEE value and will be corrected to 79% and 5S culture can be carried out properly.

Suggestion

From the research conducted, the suggestions that can be given are:

1. The key to the reliability of existing equipment is the existence of good management governance, in terms of procurement of spare parts, raw materials, and employee empowerment (Knowledge Skills), Implementation of 5S and Autonomous Maintenance.
2. Research should also concern the decision to be taken so that all needs are included in the Operational Budget.

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