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CALCULATION OF VALUE OF OVERALL EQUIPMENT EFFECTIVENESS AS A BASIS OF PRODUCTIVITY IMPROVEMENT PROCESS SHEARING LEAF SPRING IN PT INDOSPRING TBK GRESIK

Suparno[1], Imam Bahroni[2]
Industrial Engineering Department[1,2]
SekolahTinggiTeknikQomaruddin Gresik
email: suparnosttq@gmail.com

Abstract
PT. Indospring, Tbk as a motor vehicle producer industry is demanded to continuously improve the quality of products made in order to remain competitive in the current era of globalization. This is in line with the amount of demand that shows an upward trend. However, the performance of one of the production equipment that is not running optimally causes the output of production is low. From this problem, how is the OEE measurement as the basis of the proposed improvement design to improve the performance of the production equipment so as to achieve World Class Value standard.In performing these performance improvements, it is used OEE method application, Fishbone Diagram, Pareto Diagram in solving the problems that occur. OEE calculation results show that the equipment in the Eye Forming Process has the lowest OEE value compared to Cutting and Process Punching that is equal to 77.94%. This is due to 2 factors namely Performance Factor (83.83%) and Quality Factor (96.18%). The result of analysis that the biggest factor of Performance (Unplanned Down Time) is the first because the process of set up is 733 minutes (52,47%) and secondly because the problem of mandril jam is 450 minutes (32,21%) and Eye Forming Defect), The first is Eye forming Deformed 1034 pcs (60.50%) and the second is Eye forming Defect Grip as much as 381 pcs (22.29%). Based on the results of the analysis then made an improvement proposal based on the priority of critical problems that occur to improve the performance of equipment in the process.

Keywords: Shearing Production Line, Overall Equipment Effectiveness (OEE)

1. INTRODUCTION

PT. IndospringTbk is a manufacturing industry company engaged in the automotive sector. As a growing company, PT. IndospringTbk wants to continue to improve improvements in productivity and quality in order to keep the trust of domestic and foreign customers. The types of products produced by the company include Leaf Spring, Hot Coil Spring, Cold Coil Spring, Valve Spring, and Wire Ring.Based on the recommendations from the company management, leaf spring operational department was chosen as the object of observation. The reason is that in the operational leaf spring department is in the stage of development of the factory.

In the operational leaf spring department is divided into 3 process areas: the area of Shearing, Area Heat Treatment, and Assembling area. However, since there is no method used to measure the performance of machine or equipment in this area, there are some machines that are still new and also plant for single leaf. So from the explanation selected area Shearing PT process. IndospringTbk as the object of research analysis.The following data demand that occurred between September 2016 - December 2016:

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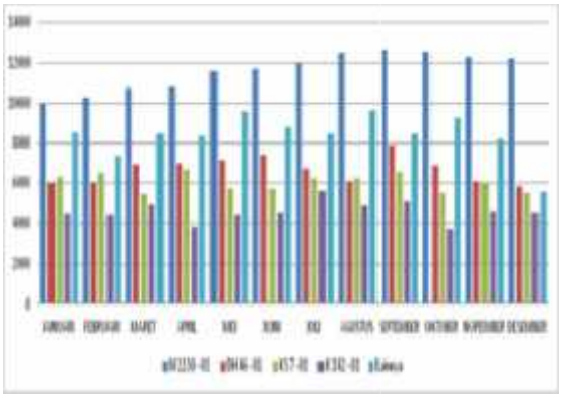

Figure 1 Demand chart data Period January - December 2016

Looking at Figure 1 shows that the demand graph for Leaf Spring products for the MSM 2230-01 type is increasing from January to December 2016. With the increasing demand for these types, PT. Indospring, Tbk strives to increase its production by optimizing the number of machines available, in order to obtain productivity and meet consumer demand, from which MSM 2230-01 is chosen as the object of research analysis.SyaifulArif (2005) conducted a study on Measuring Overall Equipment Effeectiveness as the Basic Proposed Improvement of Performance on Hot Coil Spring Process In PT IndospringTbk This research was conducted as a basis for the proposal to continuously improve the quality of Coil Spring products . However, the performance of one production equipment that does not run optimally causes the results of its production output to be low.

The efforts made in improving the performance, then used the application of the OEE method, TPM, Fishbone Diagram, Pareto Diagram in solving problems that occur. The results of the OEE calculation show that the equipment in the Coating Process has a Low OEE value compared to the SSP Process and Grinding Process which is 80.73%. This is due to two factors, namely the Performance Factor (85.60%) and Quality Factor (96.73%).The result of analysis that the biggest factor of Performance (Unplanned Down Time) due to Spray faltered 790 minutes (74.88%) and the biggest Quality Factor (Defect Product) due to the thickness of Cat NG of 1516 pcs (69.51%).

Cristian Yoko Wijaya (2015) undertakes the measurement of Overall Equipment Effectiveness (OEE) at PT Astra OtopartsTbk. AdiwiraPlastik Division Jakarta. Where the calculation of OEE value in PT Astra Otopart initially does not have a definite calculation standard. The problems faced by the company is the data from the web used in calculating the performance of the production process is less able to describe the actual conditions in the field, because the database system, SPH update system, and admin errors in the data input process Improvements to overcome this problem is to use data from the FTP replacing web data, actual SHP data collection from LHP, and improving LHP design. FTP data is the most ideal data to be used by the company because it most meets the criteria of accuracy, ease of access, and fast in obtaining data The OEE value of the plastic injection machine area 1 and 2 on using the LHP result data is 86%. OEE value is influenced by the value of 3 factors, namely availability of 88%, performance rate of 100%, and the quality rate of 98%. Factors to consider in improving and increasing the value of OEE are availability and quality rate factors.

2. METHODOLOGY

In this study, the analysis and identification of critical problems arising from the achievement of measured OEE values obtained. The results of measured OEE were comparable with world class OEE, then identification of possible low OEE values with pareto aids. Pareto is used to determine the priority scale of the issues discussed. Then the dominant or priority problem will be identified with a fishbone diagram to determine the causal relationship.

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So that later obtained direction toward clear improvement.

An analysis of the results of data processing on OEE values that have not been reached will be followed up or a scheme that can provide a proposed improvement based on the results of identification of OEE achievement factors and the identification of the critical problem. In addition, this stage also contains suggestions - improvements that aims to increase the company's OEE value by referring to Implementation of TPM Stages are:

a. Elimination of main problem.
b. Autonomous maintenance.
c. Planned maintenance program.
d. Training.

The data collected in this research are Production Data, Disabled Product Data, Time Work Details Data, Time Machine Working Details Data, Planned Down Time Data, Performance Losses / Unplanned Down Time, September - December 2016 .

Table 1 Production Results Data

Process	Total (pcs)	Average (pcs)/day
Cutting	102.073	1.020.73
Punching	79.978	799.79
Eye Forming	44.787	447.87

Table 2 Defective product data for cutting section

Item	Cutting defect product criteria			Total
	not elbows/ italics (pcs)	jembret pieces (pcs)	long outspec (pcs)	
Total (pcs)	82	15	10	107
Average (pcs)/day	0.82	0.15	0.1	1.07

Table 3Defective product data for punching section

Item	Punching defect product criteria			Total
	burry diameter (pcs)	Excentricity NG (pcs)	Out Spec Diamater (pcs)	
Total (pcs)	25	105	5	135
Average (pcs)/day	0.25	1.05	0.05	1.35

Table 4Defective product data for eye forming section

Item	Eye Forming (EF) defect product criteria			Total
	EF scratch (pcs)	EF Deformed (pcs)	EF Defect (pcs)	
Total (pcs)	294	1.034	381	1.709
Average (pcs)/day	2.94	10.34	3.81	17,09

Table 5 Details of Working Time

Number	information	time / shift
1	working time	480 minute (8 Hour)
2	Break	30 minute
3	Eat	30 minute

Table 6 Private Data of Machine Work Time

Number	information	shift operation time	production targets
1	Cutting	8 Hour	1000 Pcs
2	Punching	8 Hour	800 Pcs
3	Eye Forming	8 Hour	550 Pcs

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Table 7 Planned Down Time Data

Number	information	time / shift
1	Break	30 minute
2	Eat	30 minute
	Total	60 minute

Table 8 Unplaned Down Time Datafor cutting section

Item	Cutting			
	Sagging Stopper	Dies broke	Engine Set Up	Total
number (minutes / 4 months)	42	32	780	854
average (minutes / day)	0.42	0.32	7.8	8.54

Table 9UnplanedDown Time Data for punching section

Item	Punching			
	PuncAus	Punch Broke	Engine Set-up	Total
number (minutes / 4 months)	86	58	996	1.140
average (minutes / day)	0.86	0.58	9.96	11.40

Table 10 UnplanedDown Time Data for eye forming section

Item	Eye Forming				
	man dril is stuck	hydra ulic leakin g	unstabl e tempera ture	Engi ne Set-up	Tot al
number (minutes / 4 months)	450	111	103	733	139 7
average (minutes / day)	4.5	1.11	1.03	7.33	13. 97

In the 6th data, then the data processing is done with the calculation of each process or machine related to its OEE value factors, there are 3 factors, namely:

a. Availability,
b. Performance
c. Quality

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Where the formula used to calculate the three factors is:

$$A_t = \frac{L \quad T_l \quad - D \quad T_l}{L \quad T_l} \; x\, 100\%$$

$$P_t = \frac{p_l \quad A \quad - T_t \quad C \quad T_l}{O_t \quad T_l} \; x\, 100\%$$

$$Q = \frac{p_l \quad A \quad - d \quad A}{P_l \quad A} \; x\, 100\%$$

OEE = Avalability x Performance x Quality
So that the Overall Equipment Effectiveness (OEE) calculation recapitulation data is obtained in the MSM 2230 spring making process in the shearing area of the Cutting, Punching and Eye Forming process as follows:

Table 11 Results of OEE calculations

Process/Factor	Availability	Performance	Qulity	OEE
Cutting	97.96%	104.19 %	99.89%	101.95%
Punching	97.28%	102.76 %	99.83%	99.79 %
Eye Forming	96.67%	83.83%	96.18%	77.94 %

Comparison of OEE performance values is done by comparing the results of the calculation of the company's OEE value with world-class OEE value standards. The company's OEE value less than the World-Class OEE standard concluded that Improve should be taken, while the OEE value of the company that is more than equal to the World-Class OEE standard concluded that it meets the Good Standard.

Table 12 Comparison of OEE Cutting processes

OEE factor	Persentase OEE (World Class)	Measured OEE Results	Conclusion
Availability	90.00%	97.96%	OK
Performance	85.00%	104.19%	OK
Quality	99.00%	99.89%	OK
OEE	85.00%	101.95%	OK

The results of the comparison of OEE performance values above, the value of all OEE factors and OEE values in the Cutting process have met the standards.

Table 13 Comparison of OEE Punching process

OEE factor	Persentase OEE (World Class)	Measured OEE Results	Conclusion
Availability	90.00%	97.96%	OK
Performance	85.00%	102.76%	OK
Quality	99.00%	99.83%	OK
OEE	85.00%	99.79%	OK

From the results of the comparison of OEE performance values above shows that all OEE factor values and OEE values in the Punching process are in accordance with the standards.

Table 14 OEE comparison of Eye Forming process

OEE factor	Persentase OEE (World Class)	Measured OEE Results	Conclusion
Availability	90.00%	96.67%	OK
Performance	85.00%	83.83%	Need Improvement
Quality	99.00%	96.18%	Need Improvement
OEE	85.00%	77.95%	Need Improvement

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The result of comparison of OEE performance value above, there is only one factor that already meet the standard, that is Availability factor. Performance factors, Quality factors and OEE values have not reached the standard, so it is necessary to take corrective action.The following is a recapitulation table that results from a comparison of the OEE performance values generated:

Table 15 Comparison Data OEE performance results

Factor	Availability	Performance	Quality	OEE
World Class OEE Standard	90%	95%	99%	85%
Cutting	97.96%	104.19%	99.91 %	101.06%
Punching	97.28%	102.76%	99.88 %	99.84 %
Eye Forming	96.60%	83.83%	96.18 %	77.94 %

Identify Low OEE Value Achievement

Looking at the results of a comparison of the measured OEE performance values it is known that the Eye Foming process is a process that does not meet the standards while the Cutting process and Punching process has reached world class standards. In the Eye Forming process there are 2 OEE factors that have not met world-class OEE values, namely the Performance factor with a value of 83.83% and Quality factors with a value of 96.18%. With Performance and Quality values that are below world-class OE standards, this is very influential on the OEE value of the Eye Forming process, which does not meet world-class standards with a value of 77.94% so that corrective actions need to be taken. The low performance factor is caused by the large number of Unplanned Down Time that occur. Based on the data taken contained in Table 4:10 gives information that Unplanned Down Time on the process of Eye Forming occurred during 1397 minutes (during the period of September - December 2016). Following Data Unplanned Down Time Results:

Table 16 Data Unplaned Down Time Eye Forming Process

Item Unplanned Down Time	Number (menit)	%	% Cum
Engine Set Up	733	52.47	52.47
Mandrilis stuck	450	32.21	84.68
cylinder leaked	111	7.95	92.63
Unstable temperature	103	7.37	100
Total	1.397		

The presentation of data Unplanned Downtime by using Pareto Diagram is as follows:

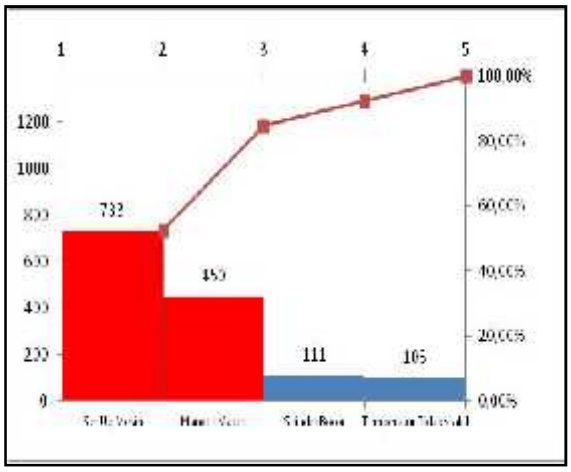

Figure 2 Pareto Unplanned Down Time The Eye Forming Process

Based on the Pareto Diagram above, it is found that the most problems that occur in the Performance factor (Unplanned Down Time) is the first because the set up process is 733 minutes (52.47%) and the second due to the problem of mandril jammed as much as 450 minutes (32.21%) so that the two problems become a priority scale to be resolved.While the second factor that affects the low value of OEE is the Quality factor caused by the number of defective products that occur. Based on the data taken contained

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in Table 4.4 gives information that the Defects products in the Eye Forming process as much as 1709 pcs (during the period of September - December 2016). The following data is the result of the defective process of the Eye Forming process:

Table 17 Results Product Defect Eye Forming Process

Defective Item	Number (pcs)	%	% Cum
Eye Forming Defomed	1.034	60.5	60.5
Eye Forming Cacat	381	22.29	82.79
Eye Forming Scratch	294	17.21	100
Total	1.709		

The presentation of product data defect Eye Forming process by using Pareto Diagram is as follows:

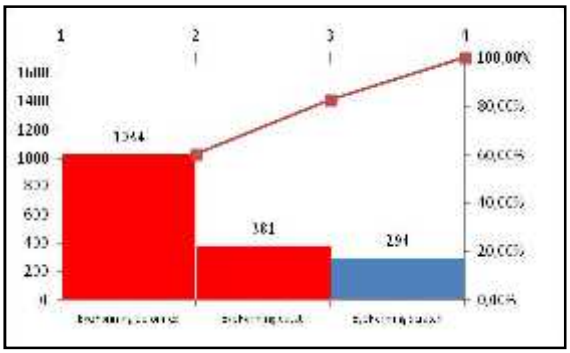

Figure 3 Pareto Product Results Defect Eye Forming Process

Based on the Pareto Diagram above, it is found that the most problems that occur on Quality factor (Defect Item) is the first is Eye forming Deformed 1034 pcs (60.50%) and the second is Eye forming Defect as much as 381 pcs (22.29%) so the two problems also become a priority scale for the repair process.

Identify Critical Performance Issues

In Figure 3 we have obtained the data that the biggest first Unplanned down time is due to the long set up of 733 minutes (52.47%) that causes the performance value to be far from the world class standard. So that the problem becomes a critical problem / priority scale that must be corrected. Here is the Fish Bone Diagram:

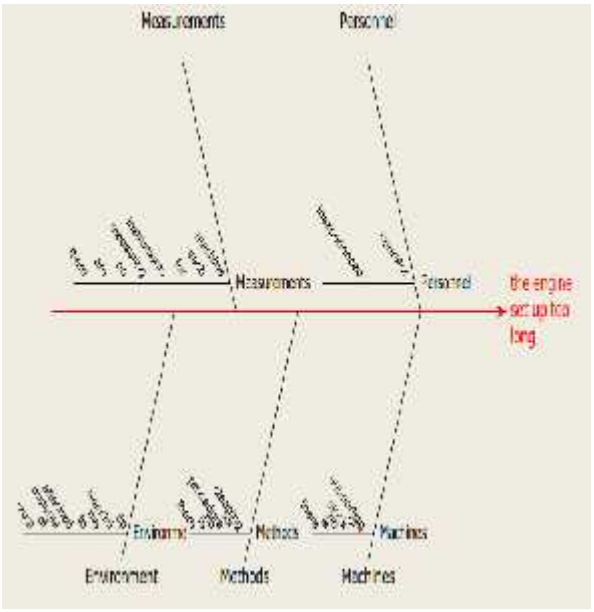

Figure 4 Fish Bond Diagram Unplanned Down Time Set Up

Here is an explanation of Figure 4:

1. Man
   Operators placed in Eye forming machines are new operators in manufacturing Leaf spring, so operators have no experience in setting up machines. This indicates that the operator is still in the learning stage about the ins and outs of Eye forming machines.Foreman who served as Set up man in their respective areas - each must perform the task well, if there is negligence in terms of set up the machine will be waste of time set up the machine.
2. Machine
   In the process of setting up the machine is also done at the same time the process of checking the condition of Dies / engine support components, so that if found the supporting components of the machine that is not functioning properly it will be replaced components, although the condition of the machine components are not damaged. This is done to accelerate the production process.

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3. Methods
   The machine or the supporting components of the machine that is in poor condition is not rapidly repaired, thus making the production process, especially the process of setting up the machine to be long because waiting to be repaired first by the Tooling part, although the repair process is not so long, but if it happens repeatedly will cause waste of machine set up time.
4. Measurement
   In the process of setting up the machine required measuring tool to check the result set up. Provision of measuring instruments for the needs of each machine placed in each area of the machine will help speed up the process of setting up the machine. This is better than using a meter alternately for multiple machines.
5. Environment
   The material's crust from the heating in the oven or end heating will stick to the end of the mandrill, if it is not routinely cleaned then it will be difficult to clean. The condition of the engine and the supporting components of the clean engine will speed up the set up process on the machine.

Whereas in Figure 2 data has been obtained that the second largest Unplanned down time is mandril is stuckof 450 minutes (32.21%). So that the problem is also a critical factor / priority scale that must be corrected. The root of the problem of the mandril jam can be known by using a causal diagram or a fish bond diagram that can provide an analysis input on the cause of the problem. With the appropriate handling can minimize the problem can be repeated. Here is the Fish Bone Diagram:

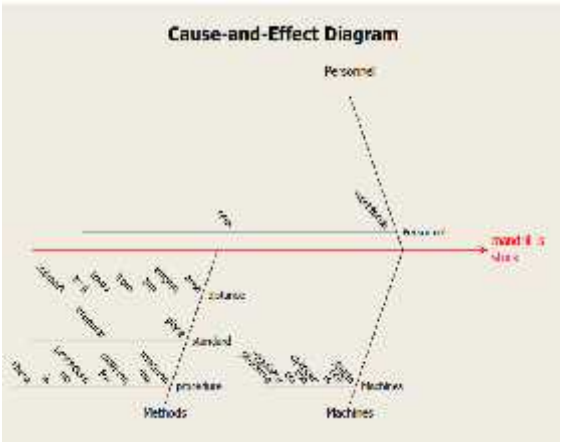

Figure 5 Fish Bone Unplanned Down Time Mandri is Stuck Diagram

Here is an explanation of Figure 5:

1. Man
   Operators placed in Eye Forming machines are new operators in manufacturing, so operators have no experience in the Eye Forming process. This indicates that operators are still in the learning process so they still need training.
2. Machines
   Wind channels sourced from compressor engines often do not work properly. The compressor wind pipe is connected to the Eye forming machine by the engine support component that acts as a wind pressure regulator, this component often does not work properly so that the wind pressure entering the engine is less than standard or more than standard.
3. Methods
4. The machine or the supporting components of the machine that is in poor condition is not rapidly repaired, thus making the production process, especially the process of setting up the machine to be long because waiting to be repaired first by the Tooling part, although the repair process is not so long, but if it happens repeatedly will lead to waste of time.

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5. **Identify the Critical Issues of Quality Factors**

   In Figure 3.2 data has been obtained that the highest defect product problem is Eye Forming Deformed by 1034 pcs (60.50%). So the problem becomes a critical factor / priority scale that must be fixed. from that finding the right root of the problem will produce the right solution and get accurate results as well. Here is the Fish Bone Diagram of the Deuce Eye Forming problem:

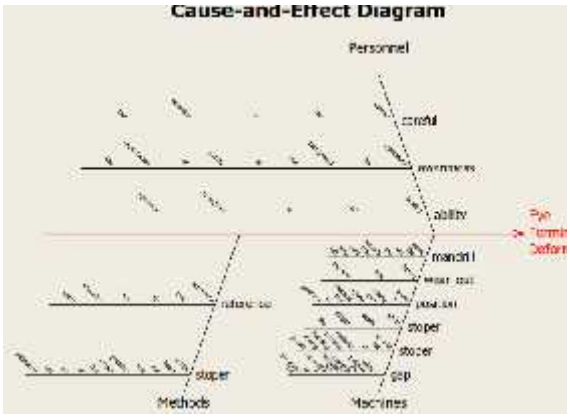

Figure 6 Diagram Fish Bone Defect Eye Deformed Defect Product

The following is an explanation of Figure 6:

1. Man

   Operators who lack experience checking product conditions should be given regular training, this aims to reduce the number of defective products. Good production results are good results in terms of quality and quantity, all operators must be given an awareness of the understanding of the importance of quality.

2. Machine

   Mandril rotation of the right and left is not the same so that the house mandril wear. This is because the cooling of the mandril house is less so that the water flow passes only the outside.The position of the material when the eye rolling is tilted because the front and rear stopper are not aligned, this happens because the locking bolt cannot hold the stopper position so that the stopper easily shifts from the predetermined initial condition.There is a gap in one side between the mandril and the material in the eye rolling process because the position of the material with the sloping dies is due to the stoper clamp material the bending process is not parallel between the front & rear stoper.

3. Methods

   The supporting component control of the machine does not exist, which is the component that regulates wind pressure from the compressor pipe to the wind cylinder. Wind cylinders that do not work stably will cause the mandrill suppressor to jam or falter, thus potentially causing deformed defects in the eye forming.The position of the stopper set-up between operators is different which results in each person having their own reference, this is because there is no written or standardized set up reference that results in eye forming deformed problems becoming more and more bad products. In Figure 4data has been obtained that the second defect product problem is Eye Forming Disability of 381 pcs (22.29%). So that the problem is also a critical problem / priority scale that must be corrected as soon as possible. Furthermore, we need to find the root of the problem to find the appropriate handling. Here is the Fish Bone Diagram:

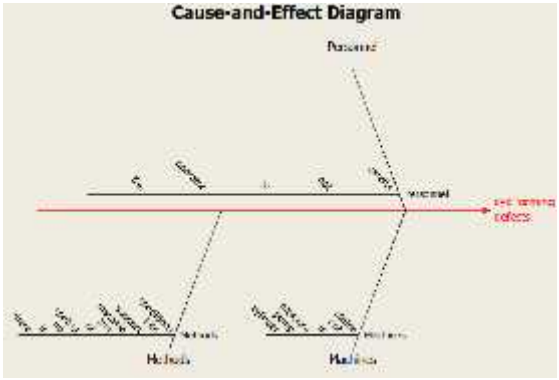

Figure 7 Eye Bone Forming Fish Bone Product Defects

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Here is an explanation of Figure 7:

1. Man

   Production operators and QC operators must work together to maintain product quality. Every operator should understand the importance of a quality. Quality Control (QC) inspector skill is very important role in maintaining product quality. A less experienced QC checks the condition of the product. Suppose that production operators and QC operators who do not charge the IRS in accordance with the filling procedure will be fatal, ie the occurrence of large defects.
2. Machines

   Pressure on the engine cylinder pump is often unstable resulting in an imperfect process of Eye Forming resulting in a defect in eye forming. pressing the mandrill and worn or defective mandrill holders can cause defects in the eye forming part, so as to influence the number of eye forming defects. Provision of tools for Maintenance operators is still limited. Maintenance operators should be equipped with complete tools, so do not alternately use the tool with the Tolling, Production, etc. section.
3. Methods

   The supporting component control of the machine does not exist, which is the component that regulates wind pressure from the compressor pipe to the wind cylinder. Unstable wind cylinders will cause the mandrill suppressors to stall or stagnate, potentially causing defects in Eye Forming. Problems that arise on the engine must be repaired as quickly as possible. Information on the problems that arise in the middle of the production process should also run well and quickly. Communication problems with the Maintenance is still not maximized. The calculation of OEE performance values states that in the Eye Forming process alone that has not met world-class standards, while the process of Cutting and Punching process meets world-class standards. In the process of Eye Forming there are 2 OEE factors that have not complied with world class standards, namely Performance factor and Quality factor. This resulted in the achievement of OEE value in the Eye forming process is still below the world class standard of only 77.94%.

The result of identification of OEE achievement factor shows that the length of Unplanned Down Time occurring in Eye Forming process resulted in not achieving Performance factor. Not achieving the Quality factor caused by the high number of product defects are eye forming deformed and eye forming defects. Based on the results of critical problem identification summed up the length of Unplanned Down Time problem of setting up the old machine and the problem of stuck mandil become the main priority that must be done immediately. For the Quality factor, Eye Forming Deformed is a priority that should also be fixed immediately. The two factors above will be discussed with the company so it is possible for the company to be able to accept the suggestion ideas for the process of performance improvement.

3. CONCLUSION

From the results of the study can be concluded as follows:

1. Based on the achievement of measured OEE performance values, the OEE value in the Eye Forming process is not in accordance with world class OEE standard, it shows that equipment performance system in that area is still less than optimal. Here is the overall value data:
   a. Cutting Process, Availability Factor = 97.96% with OK information, Performance Factor = 104.19% with OK information, Quality Factor = 99.89% with OK and OEE

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information = 101.95% with OK information.

b. Punching Process, Availability Factor = 97.28% with OK information, Performance Factor = 102.76% with OK information, Quality Factor = 99.83% with OK and OEE information = 99.79% with OK information.
c. Eye Forming Process, Availability Factor = 96.67% with OK information, Performance Factor = 83.83% with information Need Improvement, Quality Factor = 96.18% with information Needs Improvement and OEE = 77.94% with information Needs Improvement.

2. Below is an explanation of the factors that underestimated the measured value of OEE and Recommendation improvements:
   a. The Eye Forming process is the only process that has OEE performance values below the world-class OEE performance values, which only reach 77.94%, for Performance factor of 83.83%, for Quality factor of 96.18%, so it must be done Improve for all three factors. Availability factor to be the only factor that has met world-class standards, which reached a value of 96.67% with a description of OK.
   b. Causes of not achieving OEE performance value in the Eye Forming process is the length of Unplanned Down Time which is Set up the old machine for 733 minutes with an average of 7.33 minutes and MandrilMacet for 450 minutes with an average of 4.50 minutes. While the other cause is the number of defective products are high, ie Eye Forming Deformed for 1034 pcs with an average of 10.34 pcs. And Eye forming defects of 381 pcs with an average of 3.81 pcs.
   c. Recommendations for improvements made are (1) Provide regular training to all operators about the machine to be run or in the area of the machine that becomes its duty during the work activities on the machine. (2) Resocialization to all operators about the characteristics of the machine used. Perform cleaning on the machine used every day. Its purpose is to maintain and maintain the machine as part of the work activities, so that it can detect the damaged machine quickly and repair it. (3) Replacing parts of machine if there is already worn. (4) Resocialization of all operators and QC inspectors on the importance of quality awareness. Provision of training to Quality Control inspectors regularly on the standards / specifications of products made. (5) Conducted training 5R or 5S, Quality Control Circle (QCC), Contribution Suggestion Program, Discipline, Quality, Productivity and work concept in Manufacturing Industry. (6) No longer only imposes a large number of outputs but also makes quality products a top priority.

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