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Analysis of Increasing Productivity of the Production Process through the Misroll Losses Elimination Using DMIC Six Sigma

(Case Study: PT. ABC STEEL COMPANY)

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Abstract:- The market competition for reinforcing steel products in Indonesia is in the perfect competition position, where factory capacity is very unbalanced compared to existing demand, so that low cost strategic becomes a strategy that the majority is applied by manufacturers to win the market and win the competition. This encourages PT. ABC as one of the producers of reinforcement Steel evaluates production performance to look for potential improvements in order to eliminate losses / waste and other wastage with the aim of increasing productivity so that operational performance is efficient and produces quality products at competitive prices. The percentage of misroll losses or failed processes in 2014 - 2017 shows an increasing trend with an average of 1.6% and a DPMO value (defect per Million Opportunity) of 16,255 or 3.83 sigma. In this study, the DMAIC Six Sigma approach and FMEA analysis are used to eliminate misroll losses and the improvements made can reduce misroll losses to Sigma 4.0 or 6,000 DPMO levels and increase productivity by 1,500 tons / year at a production level of 150,000 tons / year

***Keywords**:- Defect elimination, DMAIC Six Sigma, Productivity, FMEA.*

I. INTRODUCTION

The current installed production capacity of all domestic steel producers is 10.2 million tons / year of market demand of 4.7 tons / year (IISIA, 2018). This condition makes competition for the Steel Reinforcement market very tight and requires all producers to make improvements to the process so that production costs are more efficient and can still compete in the market at competitive prices in addition to the quality of products that must be maintained.

PT. ABC is a pioneer company in the Reinforcement Steel Mill in Indonesia which has a strong brand image, but its production facilities have lagged behind with other competitors. The rolling mill machinery technology that is owned is the first generation engine installed in 1970 with a capacity of 150,000 tons / year. Based on production performance in 2014 - 2017 misroll losses or process failures at PT. ABC shows an increasing trend, as seen in the following Figure 1:

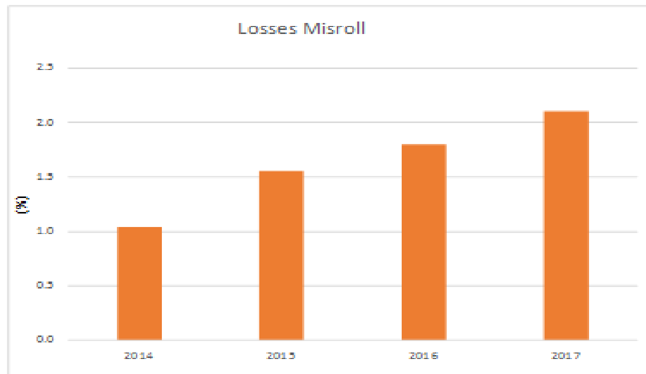

Fig 1:- Trend of misroll Losses

Losses misroll from the production process Figure 1 Trend Losses misrollReinforcing steel is a loss resulting from the failure of the process in forming or rolling from the raw material in the form of billets to reinforcing steel with a variety of product diameters namely D13 mm, D16 mm, D19 mm, D22 mm, D25mm, D29 mm and D32 mm.misroll / process failure can occur with several causes, namely:

- Man : An inconsistent production operator in checking parameters, bar dimensions and equipment in the field.
- Machine : Reliability of machinery and equipment that is influenced by the technology and quality of the machine and equipment itself.
- Material : Quality of steel raw material used.
- Method : How to check equipment conditions and bar dimensions in the field when production takes place.

II. RESEARCH METHODS

➢ *Data Collection*

In this study, the data needed are concrete iron production data in the period of 2014 - 2017 and according to Figure 1.1, it can be seen that the percentage of double losses that occur in the Reinforcement Steel Plant shows an increasing trend from year.

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➢ *Data Analysis*

This study refers to Pande and Holpp (2005), namely through the DMAIC stage (Define, Measure, Analyze, Improve and Control) that is used to solve problems and improve the effectiveness of the production process using the 5W and 1H tools.

➢ *Define Stage*

In the first stage of this study the goals and objectives were determined and the identification of misroll losses / process failure was as follows:

- *Target*

This research is expected to reduce the percentage of process / misroll failure by a minimum of 1% in 2018.

- *Aim*

The purpose of this study is to find the root of the problem from the cause of the occurrence of a double / failure process and determine the steps for repairs that must be done.

- *Identification of process / misroll failure losses.*

Based on misroll data / process failure as shown in Figure 1 after classification, based on product size as shown in Figure 2, it can be identified that the largest or dominant percentage of process / misroll failure occurs in D13 size (13 mm product diameter)

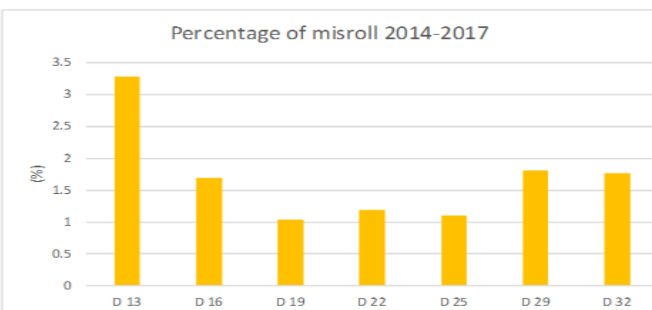

Fig 2:- Misroll Losses according to product type

➢ *Measure*

Measure is the second stage in the six sigma method. This measurement stage is carried out through two stages, namely: determining the proportion of the most dominant double / failure process that will be qualified as Critical to Quality (CTQ) using the Pareto diagram. According to the data, there is a proportion of double / process failure during 2014-2017 as follows:

Jenis Couble	Jumlah Kejadian	Couble (%)	Komulatif (%)
Over Stock	1714	40.3	40.3
Guide Wear	958	22.5	62.9
Cooling Bed	624	14.7	77.6
Motor Trip	529	12.4	90.0
Bar Broke	425	10.0	100.0

Fig 3:- Misroll frequencies of each type misroll and products

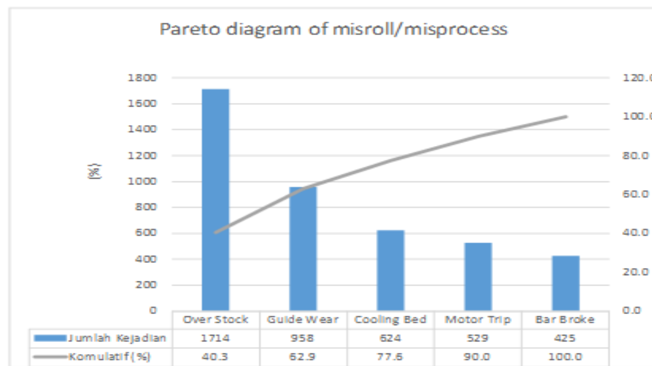

Fig 4:- Pareto diagram misroll type or process failure

Based on the pareto 4 diagram above, there are 5 CTQs that must be corrected immediately because CTQ is a characteristic that affects double losses / process failure and affects factory productivity. Then the process capability (sigma) and DPMO are calculated to determine the process capability of the misroll / process failure that has been identified.Calculation of sigma capabilities is used as a company benchmark, namely using Table Sigma Motorola.

Years	Billet (Ton)	Billet (Pcs)	Misroll (Ton)	Misroll (Time)	CTQ	DPMO	Sigma
2014	125,127	184,553	1,304	1,923	5	10,420	3.93
2015	132,268	195,086	2,061	3,039	5	15,579	3.85
2016	114,352	168,661	2,061	3,039	5	18,020	3.81
2017	95,500	140,855	2,006	2,958	5	21,000	3.76
Total	467,248	689,156	7,431	10,960		65,019	15.34
Average	116,812	172,289	1,858	2,740		16,255	3.83

Fig 5:- CTQ, Capability DPMO & Sigma

CTQ, Capability DPMO and Sigma are shown in figure 5.

- *Analysis*

After obtaining data at the stage of determining and measuring, the third stage identifies the causes of quality problems, namely the occurrence of misroll / process failure. This can be done using the P (Chart) control diagram which will find out whether there are products that are outside the control limit or not. In this study the target or target has been determined, namely reducing the percentage of misroll by 1% from an average of 1.7% to 0.7%. So the misroll / process failure target is controlled at 0.7% and the upper limit (UCL) and lower limit (LCL) as follows:

$$LCL = p - 3\sqrt{\frac{p(1-p)}{n}} = 0.18\ \%$$

$$UCL = p - 3\sqrt{\frac{p(1-p)}{n}} = 1.22\ \%$$

From the above P, LCL and UCL target values, the misroll control / process failure map is described as follows:

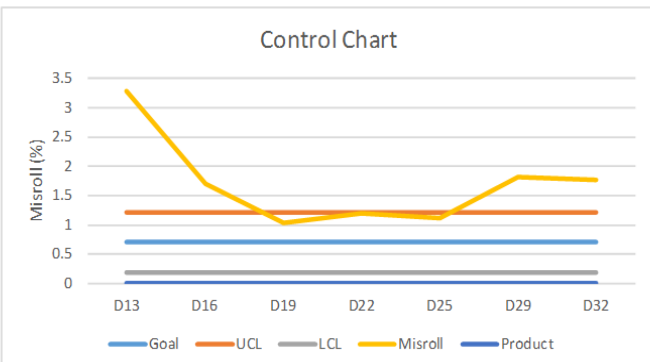

Fig 6:- Control chartmisroll

From the control chart above with the process / misroll target of 0.7% there are 3 products, namely D13, D16, D29 and D32 where the level of the misroll is still outside the map boundary.

- *Improve*

At this stage of improvement, the FMEA method (Failure Mode and Effect Analysis) is carried out. The basic reference for making FMEA comes from a causal diagram. FMEA is one method used to measure performance, design, process and service. FMEA can also identify and research related to potential failures that occur. This method will determine and multiply the severity (severity), occurrence (occurrence) and detection (detection) No 3, Make a Risk Priority Number (RPN). The highest RPN value will be a value in carrying out corrective actions (Sari et al, 2011).

The next step is the steps to make FMEA, namely:

- Potential failure mode (follow change bid mode), at this stage the process of the problem that often occurs in the driving process is done, because of Over stock, Guide wear, Tucked CB, Motor trip, and Bar broke.

- Potential effects of failure (convergence), a context that will occur if there is a disturbance that occurs, which appears in each of the problems that occur in the potential failure mode.

- Potential causes of failure (failure), At this stage mentioned or what causes the process, which will be an effect and mode. The results of making FMEA are shown in the following Table 1:

Potensial Failure Mode	Potential Effect of Failure	Potential Causes of Failure
Over Stock	Bar can't enter to the guide Output overfill & Overstock Value of angle twist change	Still used the fiber bearing Wear can't be predictable Too late change of bearing
Guide Wear/Broken	Bar can't enter the roll Output overfill & over stock Value of angle twist change	Bar over stock Temperatur bar too low Hit by the end of the bar
Motor Trip	Bar can't enter to the roll	Temperatur bar too low Bar overstock/high reduction Drive control broken
Bar Broken	Bar pinched in the guide Output bar overfill	Bad quality of the billet Flying share does not work Bar over stock and overfill
Cooling Bed (CB)	Bar did't transferred to CB Bar piled on appron	TMT parameter change Level lifting valve did't same Rolling running did't smooth

Table 1:- FMEA

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At this stage it aims to implement plans and corrective actions contained in Six Sigma projects to eliminate and prevent the occurrence of misroll / repeated process failures. There are tools in Six Sigma that are most often used for this action plan, is FMEA (Failure Mode and Effect Analysis) which is a structured procedure to identify and prevent as much as possible a process failure or misroll from a process. In FMEA tools there are three types of ratings, namely Occurrence, Severity and Detectability. The three ratings will be put together in a table, the values of the three will be related to CTQ - CTQ that has been identified from the product.

According to the Pareto chart, the type of misroll / process failure due to bar over stock and guide damage has a very high percentage value and is significant to the high losses due to the process of rubbing / failure. Next, a corrective action is taken on the type of misroll because the over-stock bar and guide damage as shown in Table 2 below.

Priority	Potential Causes of Failure	RPN	Action Plan
1	Still used fiber bearing	1714	Change with roller bearing chock
	Wear can't be predictable		Change with houshingless stand
	Too late change the bearing		
2	Bar over stock	958	Change with roller bearing chock
	Temperatur too low		Change with houshingless stand
	Hit by the end of the bar		Guide & Restbar more strong

Table 2:- Plan for improvement

By carrying out remedial actions through replacing fiber bearings with roller bearings on booths 1-7 the dimensions of the bar will be very stable where the dimensions of the bar will change if there is wear from the roll which is more predictable so that misroll due to over 100% can be eliminated and from damage the guide will be very reduced by at least 75%. The impact of the repairs carried out will reduce the percentage of double / process failure by 1% with the number of DPO 6,000 and level 4 sigma as in table 3 below:

Years	Billet (Ton)	Billet (Batang)	Misroll (Ton)	Misroll (Kali)	Misroll (%)	DPMO	Siqma
Average 2014-2017	116,812	172,289	1,858	2,740	1.6	16,255	3.83
Goal 2018	150,000	221,239	900	1,327	0.6	6,000	4.00

Table 3:- Result after improvement

➢ *Control*

The control phase is the last operational stage in the six sigma quality improvement project. At this stage the results of quality improvement are documented and disseminated, best practices that are successful in improving the standardization process and are used as standard work guidelines, as well as ownership and processors, which means that six sigma ends at this stage (Susetyo et al., 2011).

III. CONCLUSION

With the application of DMAIC Six Sigma and FMEA in analyzing the problems that occur in the process of rolling steel reinforcement in the period 2014 - 2017 can provide a decrease in the percentage of misroll or process failure by 1%, namely 0, 6% misroll, DPMO 6,000 and level 4 sigma in operation production in 2018.

The root of the problem that causes a high percentage of process failure / misroll is the use of production engine technology in 1960, the stand still uses fiber bearing as a roll bearing. The wear life and wear of fiber bearings cannot be predicted causing the bar dimensions to be unstable and tend to grow (Over stock).

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