

Design Improvement At Shearing And Tandem Cold Milling Process Of Full Hard 0,2 X 914 Mm Products In Steel Manufacturing With Six Sigma Method

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Abstract. This research aims to address the problems that are facing a largest steel manufacturing in Indonesia in producing steel is production failure that is caused by process so that it produces defect. The steel manufacturing produces 3 types of products, the named are Hot Rolled Plate, As Rolled and Full Hard. For Full Hard products there are 3 types of popular sizes that are often produced, the sizes are 0.2 x 914 mm, 0.25 x 914 mm and 0.7 x 1219 mm. When compared to the two popular sizes, Full Hard 0.2 x 914 mm products have the highest number of defective products. The percentage of these non-achievements is indicated by defects as in the year 2018 of January until December occurred a defective average of 16% or 1,617 tons This research will focus on improving the Shearing process and the Tandem Cold Mill that causes Saw Tooth Edge, Pick Up and Friction Pick Up defects. This research is done by using Six Sigma methodology (DMAIC) is used to minimize the occurrence of problems in the Shearing process and the Tandem Cold Mill. To find out the cause of a defect in a problematic process, an analysis using fishbone diagrams and 5 why's, then determines the defect repair priority using FMEA.

Introduction

Quality is an ever-changing situation that is related to products, services, people, processes, and environments that meet or exceed expectations and help generate added value [1]. Quality products begins with understanding customer needs and ends when those needs are met [2]. Then the company, especially in the industrial field must always try to improve their competitiveness one way to improve quality.

This manufacturing is a largest steel manufacturing in Indonesia. The steel manufacturing is divided into 6 plants, one of which is the Cold Rolling Mill (CRM) or Cold Roll Steel. The CRM plant unit produces 3 types of products, the named are Hot Rolled Plate, As Rolled and Full Hard.

This research will focus on Full Hard products because these types of products are routinely produced. In producing Full Hard 0.2 x 914 mm products, the CRM plant establishes product specifications that must be met in accordance with the wishes and needs of consumers and the capabilities of the company. These specifications are explained in the form of Critical to Quality (CTQ), as can be seen in Table 1.

Table 1 CTQ's Full Hard Products

Need	Quality Drivers	Product Performance Requirement
Product Suitability Visual	The coil roll has a right and left edge with a smooth texture	Rolls of the right and left edges of the coil are not jagged
	Coil rolls have a smooth surface texture	There are no spots on the coil surface
		There is no line on the coil surface
		There is no scratch on the coil surface
	The coil roll has a flat right and left edge	There are no waves on the right and left edges of the coil
	Coil rolls have a flat surface	There is no wave on the center of the coil surface
	Coil coil has thick order	Coil has thick according to customer orders
Coil cross section is a perfect circle	There is no coil coil coming out of the coil standard diameter	

Table 2 Data on Total Production and Total Defects of Full Hard Products 0.2 x 914 mm

Month	Production Target	Product Realization	Number of Products Defect	Amount of Good Product	% Product Defect
a	b	c	d	e = c-d	f = d/c
January	9.685	9764	1839	7.925	19%
February	11.333	13784	4450	9.334	32%
March	12.268	10921	3091	7.830	28%
April	18.020	17882	1987	15.896	11%
May	16.109	22170	2048	20.122	9%
June	16.463	20513	2132	18.381	10%
July	1.129	1298	180	1.118	14%
August	7.035	4187	768	3.419	18%
September	16.885	16872	2133	14.739	13%
October	1.515	1916	492	1.424	26%
November	920	1595	184	1.411	12%
December	614	737	101	636	14%
Amount	111.976	121.637	19.404	102.234	

Based on Table 2, it can be seen that the current production process starts from the period of January 2018 until December 2018 still produces defect products. It is known that the average number of defect products in Full Hard products is 0.2 x 914 mm in the past year as many as 1,617 tons. Allegedly, in the process of producing Full Hard 0.2 x 914 mm products it has not run well. From the calculation of the calculated process capability, it can be seen that the production performance of Full Hard 0.2 x 914 mm products is at the level of 3.4 sigma which is equivalent to DPMO - 28,700 (28,700 defects per 1,000,000 products). To find out which process is problematic, a further search is carried out to find the root cause of the process that is running. Then the next step is to identify the production process line for Full Hard products of 0.2 x 914 mm.

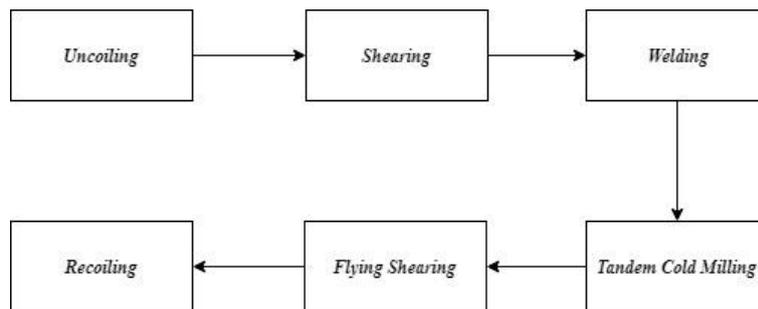


Fig. 1 Mill CTCM (Continuous Tandem Cold Mill) Process Flow

Based on Figure 1, it can be seen that the production process on Continuous Tandem Cold Mill (CTCM) consists of 6 processes. The following Table 3 is the result of identification of the types of defects that occur at the stage of the problematic process.

Table 3 Identification of the types of defects that occur in problematic stages of the process

Defect Type	Process	Stages Process Troubled	Problems Identification
Saw Tooth Edge	Shearing	Cutting the right and left sides of the coil sheet 2-3 cm long	The cutting blades used does not match coil thickness specifications
Pick Up	Tandem Cold Milling	The coil sheet is pushed into the tandem cold milling machine using the entry looper	The surface of the coil sheet has foreign impurities
Friction Pick Up		Spraying Rolling Oil from booths 1 to 5	Setting the temperature and pressure of rolling oil is not appropriate

Table 4 Defect Type of Shearing dan Tandem Cold Milling Process

Process	Defect Type	Characteristic	Image
Shearing	Saw Tooth Edge	Uneven coil edges form teeth	
Tandem Cold Milling	Pick Up	Depression on the coil surface with a large / small pattern	
	Friction Pick Up	There are lines on the coil surface	

Based on Table 4, it can be seen the types of defects that occur due to problematic processes, namely the shearing and tandem cold milling processes. Then a study entitled “Design Improvement At Shearing And Tandem Cold Milling Process Of Full Hard 0,2 X 914 Mm Products In Steel Manufacturing With Six Sigma Method”

Literature References

Quality

Quality is defined into several categories, namely: transcendent, product-based user-based, manufacturing-based and value-based. The word quality is often used to signify the superiority of a product or service [3].

Six Sigma

Six Sigma has at least three meanings, depending on the context [4].

- First, it is seen as a measure of quality. Sigma is a Greek letter that measures variation in a process.
- Second, Six Sigma can be seen as a business improvement strategy and philosophy.
- Third, as a solving methodology that seeks to find and eliminate causes of defects or errors in business processes by focusing on critical process output in the eyes of customers.

DMAIC

DMAIC stands for five phases namely: Define, Measure, Analyze, Improve and Control. DMAIC is a methodology used for improvements that aims to increase cycle time, quality and cost effectively on Six Sigma [5].

CTQ

CTQ characteristics (CTQs) are developed to meet valuable customer needs. Customer satisfaction is a major factor in developing CTQ parameters. Critical to Quality is what is the customer's expectation of a product [6].

Control Chart -P

Control chart is a line diagram used to measure process stability based on the principle of normal distribution [4]. The purpose of the use of control maps is to study the stability of the process, analyze the process so that it can identify the causes that must be taken corrective actions and process control over a period of time.

Process Capability

Process capability measures the degree of nonconformity of a process by stating performance in the form of a single number and involves calculating specification boundary ratios (customer requirements) to process deployment (variation in process) [7].

Fishbone

As a first step in identifying potential root causes of a problem, it is presented in the form of a cause and effect diagram. All causes are categorized into different categories such as humans, machines, materials, methods, measurement systems and others. A cause and effect diagram also known as a fish bone diagram or Ishikawa diagram [4].

5 Why's

5 Why's is a simple but powerful tool to quickly uncover the root of the problem, so you can deal with it once and for all. The root problem analysis is most effective when the answer comes from people who have direct experience of the process being examined [4].

FMEA

Failure Modes and Effects Analysis (FMEA) is a step-by-step approach to identifying all possible failures in design, manufacturing or service processes, or systems or assemblies. 'Failure Modes' means the way, or mode, in something that might fail. The aim of FMEA is to take action to eliminate or reduce failure, starting with the highest priority [4].

Maintenance

Maintenance or maintenance is an activity to restore functions from the machine or system to normal functions. Maintenance aims to extend the useful life of a facility, ensure that the equipment installed is in accordance with optimal functions, ensure operational readiness of all facilities and equipment needed in emergency activities and ensure the safety of everyone using the facility [8].

Regression Analysis

Regression analysis is used to estimate the relationship between several variables and identify the model between output characteristics and input variables. In regression analysis, the equation of a functional relationship is $y = f(x)$ between two identified variables. The simplest form of regression analysis is a linear relationship between x and y in the form $y = a + b(x)$, where a and b are constants that must be calculated from the data that has been obtained [4].

Parameter Estimation

Estimation is a process of estimating the value of a parameter based on information that has been obtained from a sample. There are two types of statistical estimates in a parameter estimate, namely point estimate and interval estimate [9].

Visual Display Typography

Visual display is a tool used to convey information designed to be captured by humans such as posters, chats, directions, bulletin boards, and others. One of the main factors in designing visual displays is letter size. One science that discusses font size is typography [10].

The Results and Discussion

The Result of Proposed Draft Maintenance and Maintenance of Shearing Blades

Making a maintenance schedule on part of the blade spare parts is intended to make the operator carry out maintenance of the blade spare parts regularly and regularly to avoid damage to the blade spare

parts during production. Based on the results of calculations that have been done, the MTTF value is 79.85 hours, while the MTTR calculation results are 80 seconds, which indicates the possibility of long repairs in the event of damage. From the information obtained, the operator of the shearing blades must carry out maintenance or maintenance activities before the 3rd day to prevent damage to the part of the shearing blades.

The Result of the Shearing Blade Change Sheet

The purpose of making this spare part replacement sheet is for the operator to know and do data collection on the implementation of the change of blade spare parts so that the production process will run smoothly. This spare part replacement sheet will be stored on the information board located in the blade spare parts storage area and the monitoring area is always carried out by the supervisor of the storage area so that maintenance division operators can carry out maintenance actions according to a predetermined schedule.

		Lembar Pergantian Sparepart Pisau Pemotongan Tepi Coil				
		Nama Sparepart		Periode		
		Operator Penanggung Jawab		Bulan	Tahun	
No	Pemakaian Awal		Pergantian Sparepart Selanjutnya		Tanda Tangan Operator	Catatan
	Date	Time	Date	Time		
Mengetahui						
Supervisor QC		Supervisor Area		Supervisor Maintenance		Supervisor Produksi

Fig. 2 Shearing Blade Spare Parts Change Sheet

The Result of the Proposed Design of Making Visual Display for Information on the Use of Shearing Blades

Making displays aims to facilitate the operator when replacing the shearing blade according to coil thickness specifications that will be produced and make it easier for the operator to re-examine the shearing blades to be used. Visibility to the proposed display is approximately 80 cm. Determining this distance is based on the maximum visibility that the operator can clearly see while in the blades storage area. Next is the calculation of the font size for the display.

Table 5 Results of Visual Display Font Size Calculation

Uppercase Height	4 mm	Distance Between Two Letters	1 mm
Uppercase Width	2,67 mm	Distance Between Two Words	2,67 mm
Uppercase Thickness	0,67 mm	Distance Between Rows and Sentences	2,67 mm

INFORMATION BOARD	
TEBAL COIL (mm)	KODE PISAU
(0,2 - 0,7)	SM-0600-B1
(0,73 - 1,5)	SM-1200-A1
(1,55 - 2,2)	SM-1200-A2

Fig. 3 Visual Display Information on Use of Blades Shearing According to Specifications



Fig. 4 Shearing Blade Storage Place

The Result of the Proposed Design of Cleaning Tools in the Cold Milling Tandem Process

Spray Nozzle which is used as a surface cleaning aid coil using F type flat fan nozzle. F flat fan nozzle is designed for high pressure cleaning. The specially designed inner component of the nozzle allows the flow of steam to come out with even spray, which results in effective and even cleaning of the surface being processed. The following is a design of coil surface cleaning tools:



Fig. 5 Flat Fan Type F Nozzle Spray



Fig. 6 Coil Surface Cleaning Tools

The Result for Optimizing the Temperature and Pressure of Rolling Oil

Optimizing the temperature and pressure used when spraying rolling oil in the reduction process aims to reduce the number of Friction Pick Up defects. From the results of data processing using simple linear regression calculations the optimum temperature is 56 °C. Then the parameter estimation calculation is done to get the rolling oil temperature interval. The temperature interval for rolling oil that should be used is $55,923 < \mu < 60,077$. This a large temperature of 56 °C is between the specified intervals.

Then calculating the pressure used in stand 1 through stand 5 using simple linear regression. Based on the data processing that has been done, the optimum pressure value is obtained at stand 1 with a pressure of 1.6 bar, stand 2 with a pressure of 2.7 bar, stand 3 with a pressure of 2.8 bar, stand 4 with a pressure of 3.2 bar and stand 5 with a pressure of 2.6 bar.

Conclusion

Based on the results of the analysis of the root causes of defect problems that occur in the Shearing process and the Tandem Cold Milling process when producing Full Hard 0.2 x 914 mm products in steel manufacturing, the proposed design improvements are as follows:

- a. Calculation of time interval for repairing shearing blades
- b. Making a shearing blade change sheet
- c. The design proposal for making visual displays as information for using a Shearing blades according to specifications.
- d. Proposed Design of cleaning tools automatically in the form of a nozzle cleaning tool.
- e. Optimizing the temperature and pressure of rolling oil using linear regression and parameter estimation

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