

Application of Quality Control Circle Method in Crusher Knife Reconditioning Products (Case Study in PT. Andritz Pekanbaru)

Samuel Tambunan ^{a,*}, Anita Susilawati ^a, and Yohanes ^a

^{a)} *Laboratory of Production Technology, Mechanical Engineering Department, Universitas Riau, Indonesia*

*Corresponding author: samuel.putratambunan@student.unri.ac.id

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ABSTRACT

The purpose of this study is to identify, analyze and evaluate the influencing of defects factors at the crusher knife reconditioning process in PT Andritz Pekanbaru. In this research adopted the Quality Control Circle (QCC) method. The QCC method is a quality control that is focused on the process of Plan, Do, Check, Action (PDCA). The research was carried out with 8 stages of PDCA, namely determining the theme, determining the title, finding the source of the problem, solving the problem plan, implementing, evaluating, standardizing, and determining the next plan. After observing the crusher knife reconditioning process, there were 10 defects that occurred in the crusher knife reconditioning process, which were porosity of 673 cases, curling tip of 78 cases and 57 of fewer cases followed. The repairs were carried out using the QCC method. The results of improvements were proved by reducing of the percentage of total defect porosity from 13% to 2%. Therefore, the repairs were successfully implementation, which decreasing of the defect porosity of 11%.

KEY WORDS: *Quality Control Circle, PDCA, Crusher Knife, Porosity.*

1.0 INTRODUCTION

The quality control is one way to improve product quality and competitiveness. According to Assauri [1], the control activities can ensure the production activities and operations that carried out in accordance to planning and deviations can be corrected.

The quality is defined as the number of attributes or traits as described in the product (from service) concerned. The quality control in this case is an activity in company management to sustain the company's products quality as well as services, to be maintained as planned [2]. The QCC method has structured and measurable steps to solve problems based on data and facts, which can be improved [3-5]. Using the QCC method can find out the dominant cause of defects in the product due to human factors, material, methods and the environment [6-9]. The QCC is a quality control that is focused on the process of PDCA (Plan, Do, Check, Action) and based on seven tools [2-5]. Therefore, the implementation of QCC is needed to determine the cause of a problem and a solution to resolve the problem.

The defective products can be controlled through quality control method [7-9]. The quality control is not only controlling the quality of the production process, but the transportation process is also a major factor causing defective products [10]. The quality control aims to maintain product quality in accordance with standards and improve product quality [11,12]. The improving product quality can make these products more known, so that market demand increases and company profits also increase. Furthermore, by eliminating product defects can reduce production costs [6-7].

PT. Andritz Pekanbaru is a pulp and paper machine component provider company, experiencing problems with the quality of the crusher knife items. Defect in crusher knife reconditioning process become a quality problem at PT. Andritz Pekanbaru. An improvement in terms of the process is needed to reduce the number of defects that occur using the Quality Control Circle (QCC) method. The use of the QCC method because its method focuses on controlling product quality in making improvements with the seven tools based the PDCA cycle [2,3]. The purpose of this study is to improve, implement and evaluate the results of improvements of defects factors at crusher knife reconditioning process in PT Andritz Pekanbaru. The research will be carried out with 8 stages of PDCA, namely determining the theme, determining the title, finding the source of the problem, problem solving plan, implementing, evaluating, standardizing, and determining the next plan [2,4,5,11].

2.0 METHODOLOGY

In this paper was the presence of defective products in the crusher knife reconditioning process at PT. Andritz Pekanbaru for every months in 2018. The QCC method to reduce the number of defective products was adopted in this paper. The steps that are applied to QCC are the stages of Plan, Do, Check, Action.

The flow chart of the research to be conducted, can be seen in Figure 1.

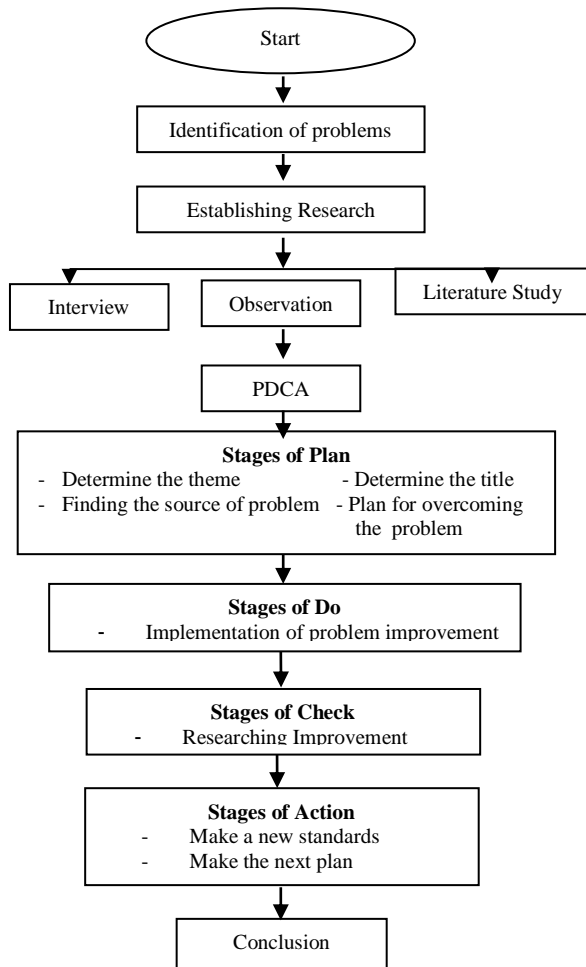


Figure 1: Flowchart of research

2.1 Stages of Plan

Determine the Theme

In stage of determining the theme, the object of research in this paper was the crusher knife product recondition.

Determine the Title

The title of the research is based on the problems that have been discussed when determining the theme.

Finding the source of the problem

To carry out a repair plan, the implementation is based on the results of the crusher knife defect data analysis. The analysis was carried out using several tools, including histogram graphs, control charts, pareto diagrams.

Look for the dominant causal factors

To analyze the factors of causing of the defect based the main problem in the Pareto diagram analysis. The analysis used a causal diagram or fish bone diagram.

2.2 Stages of Do

Implementation of Improvement

After identifying the cause of the defect in the product to be analyzed, then one would be repaired and implemented.

2.3 Stages of Check

Researching Improvement Results

In this step is to observe the results of the repairs that have been made to the crusher knife recondition process. This stage, comparison of defect data for the period from January 2018 - December 2018 (before repairs are made) and the monitoring period during March 2019 - September 2019 would be compared. Therefore, it can be revealed whether all the improvements resulting of a reduction in the number of crusher knife defects.

2.4 Stages of Action

Make new standards

In this stage, in this paper describes the improvements that have been made, and design a new standard or a new SOP (Standard OF Operation).

Make the next plan

At this stage, the defect factors that must be eliminated and made further improvement.

3.0 RESULTS

3.1 Theme Selection

The interviews were conducted in the company case study to investigate the quality problems experienced by the management of PT. Andritz Pekanbaru in term of the process of reconditioning crusher knife products. This obstacle can be based on the new procedure in PT. Andritz Pekanbaru to carrying out the reconditioning process of crusher knife products. Moreover, on the basis of the problems raised by the management of PT. Andritz Pekanbaru, which to determine the theme of quality control in the crusher knife reconditioning process in PT. Andritz Pekanbaru.

3.2 Determine the Title

The title of research to be taken is "Application of Quality Control Circle Method in Crusher Knife Reconditioning Products (Case Study in PT. Andritz Pekanbaru)"

3.3 The Problem Sources

Stratification

Classification is based on the production department and the type of defect that has occurred.

Table 1: Stratification of defect types grouping

Department	Defect Types
Welding	Crack
	Porosity
	Incomplete Welding
Machining	Curling Machining Tip
	Pocket Size Less
	Pocket Size Plus
	Slot Size Less
	Slot Size Plus
Finishing	Not Sharp
Quality Control	Complain Costumer

Histogram Graph

Based on crusher knife product defect data from January 2018 to December 2018, there were occurred several product defect incidents. In Figure 2 shows the crusher knife recondition defect histogram based on data collection for one year, starting from January 2018 to December 2018.

It can be seen on the histogram in Figure 2 that is the highest number of defects in the crusher knife reconditioning process of the porosity, which type of damage of 673 events. Followed by curling machining tip are 78 events.

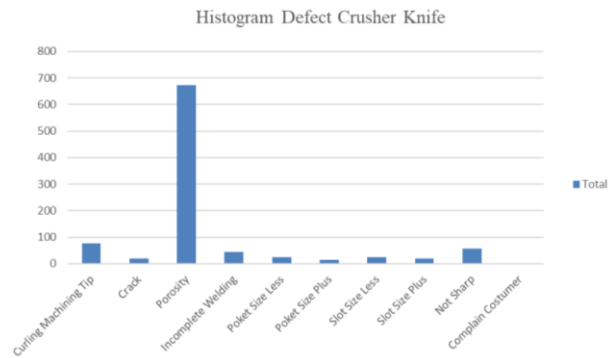


Figure 2: Chart of histogram

Table 2: Types of Defects and the number of defects in Crusher Knife reconditioning products for the period January 2018 - December 2018 (QHSE Department of PT. Andritz Pekanbaru)

Type of Defect	Defect Crusher Knife Per Month												Total
	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sep	Oct	Nov	Des	
Curling Machining Tip	6	6	10	8	6	8	11	9	4	8	6	2	78
Crack	5	2	2	2	3	0	0	1	2	5	2	1	20
Porosity	78	82	74	69	58	61	52	56	46	88	49	38	673
Incomplete Welding	4	3	5	10	3	7	3	3	2	4	1	4	45
Poket Size Less	2	0	5	3	2	1	0	3	4	6	0	1	25
Poket Size Plus	3	1	2	0	0	0	0	3	1	3	2	2	14
Slot Size Less	4	5	5	3	1	2	2	1	1	2	1	1	24
Slot Size Plus	2	2	4	4	2	1	1	1	0	2	0	2	19
Not Sharp	8	4	17	14	7	2	2	3	1	3	2	2	57
Complain Costumer	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Defect	112	105	124	113	82	82	71	80	61	121	63	53	1067

Control Chart p

- a. The calculation of percentage of recondition defect crusher knife:

$$p = \frac{n_p}{n}$$

Information:

n_p = number of failed subgroups

n = the number checked in subgroups group

Subgroup month:

$$\text{January: } p = \frac{n_p}{n} = \frac{112}{510} = 0.2196$$

- b. Calculate the center line / Central Line (CL)

$$CL = \bar{p} = \frac{\sum n_p}{\sum n}$$

Information:

$\sum n_p$ = Total amount of damage

$\sum n$ = Total number checked

Then the calculation is:

$$CL = \bar{p} = \frac{\sum n_p}{\sum n} = \frac{\sum 1067}{\sum 5904} = 0.1807$$

- c. Calculate the Upper Control Limit (UCL)

To calculate the upper control limit or UCL is done by the formula as follows:

$$UCL = \bar{p} + 3 \sqrt{\frac{\bar{p}(1-\bar{p})}{ni}}$$

Information:

\bar{p} = Center line

ni = Average production amount

The calculations are as follows:

$$\begin{aligned} UCL &= \bar{p} + 3 \sqrt{\frac{\bar{p}(1-\bar{p})}{ni}} \\ &= 0.1807 + 3 \sqrt{\frac{0.1807(1-0.1789)}{492}} \\ &= 0.2328 \end{aligned}$$

- d. Calculate the Lower Control Limit (LCL)

To calculate the lower control limit or LCL is done by the formula as follows:

$$LCL = \bar{p} - 3 \sqrt{\frac{\bar{p}(1-\bar{p})}{ni}}$$

Information:

\bar{p} = Center line

ni = Average production amount

The calculations are as follows:

$$\begin{aligned} LCL &= \bar{p} - 3 \sqrt{\frac{\bar{p}(1-\bar{p})}{ni}} \\ &= 0.1807 - 3 \sqrt{\frac{0.1807(1-0.1789)}{492}} \\ &= 0.1286 \end{aligned}$$

From the results of the calculations in the Table 2, it can be done to make a control charts P that is depicted in Figure 3.

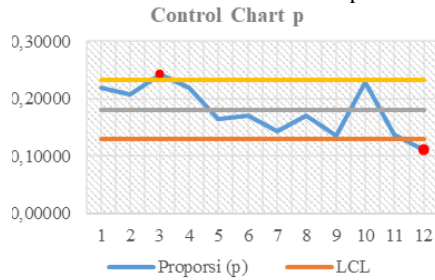


Figure 3: Control Chart p

From the graph in Figure 3, it can be concluded the quality control of crusher knife reconditioning process in PT. Andritz Pekanbaru still experiencing irregularities and needs improvement.

Pareto Diagram

The cumulative percentage is useful for stating how many differences exist in the frequency of occurrence between some dominant problems.

Based on the data processing, a Pareto diagram can be arranged (Figure 4).

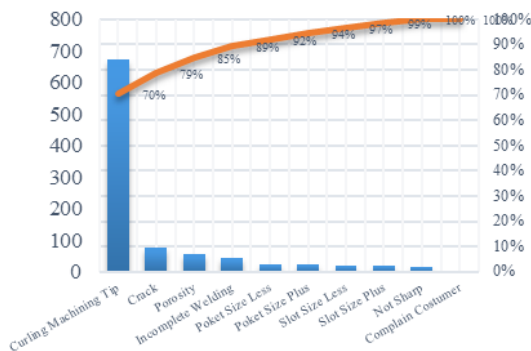


Figure 4: Pareto diagram of the defect crusher knife recondition

Table 3: Cumulative Total Defect

Defect Name	Total	Cumulative	% Defect	% Defect Cumulative
Curling Machining Tip	673	673	70%	70%
Crack	78	751	8%	79%
Porosity	57	808	6%	85%
Incomplete Welding	45	853	5%	89%
Poket Size Less	25	878	3%	92%
Poket Size Plus	24	902	3%	94%
Slot Size Less	20	922	2%	97%
Slot Size Plus	19	941	2%	99%
Not Sharp	14	955	1%	100%
Complain Costumer	0	955	0%	100%

From the observations of the existing Pareto diagram, it can be seen that 80% of the damage to the crusher knife reconditioning product that occurred in the January 2018 to December 2018 period was dominated by 2 types of defects namely porosity and curly tip, with a percentage of 70% porosity and curly tip by 8%.

Target Improvement

Percentage of comparison of the occurrence of defect porosity to the total production occurred during data collection was 13%.

Based on this, the improvements that will be made will be based on the target set by the company, namely the reduction in defects from 13% to below 10%.

Table 4: Percentage Table of Comparison of Porosity and Number of Products.

Month	Porosity	Number of production	Percentage
January	78	510	15%
February	82	504	16%
March	74	510	15%
April	69	515	13%
May	58	500	12%
June	61	480	13%
July	52	495	11%
August	56	470	12%
September	46	450	10%
October	88	530	17%
November	49	460	11%
December	38	480	8%
Total	751	5904	13%

Cause and Effect Diagrams (Fishbone Chart)

The factors that influence in making this diagram are as follows:

- Material: everything that is used by the company as a product component for production. The material in question is the main raw material and supporting raw materials.
- Man: the workers involved in the production process both in processing raw materials into finished materials.
- Machine / tools: equipment or machinery used in the production process.
- Method: work procedures or instructions that must be followed by workers in carrying out the production process.
- Environment: external circumstances or around the company that directly or indirectly can affect the production process specifically.

After knowing the types of defects, which has the biggest value of the defects then its can be analyzed for the crusher knife reconditioning process at PT. Andritz Pekanbaru. The next step is to take corrective action to prevent and reduce the number of defects that have been determined. As a tool to analyze the cause of the defect, a causal diagram or commonly called a fishbone chart. The fish bone chart for porosity defects is depicted in Figure 5.

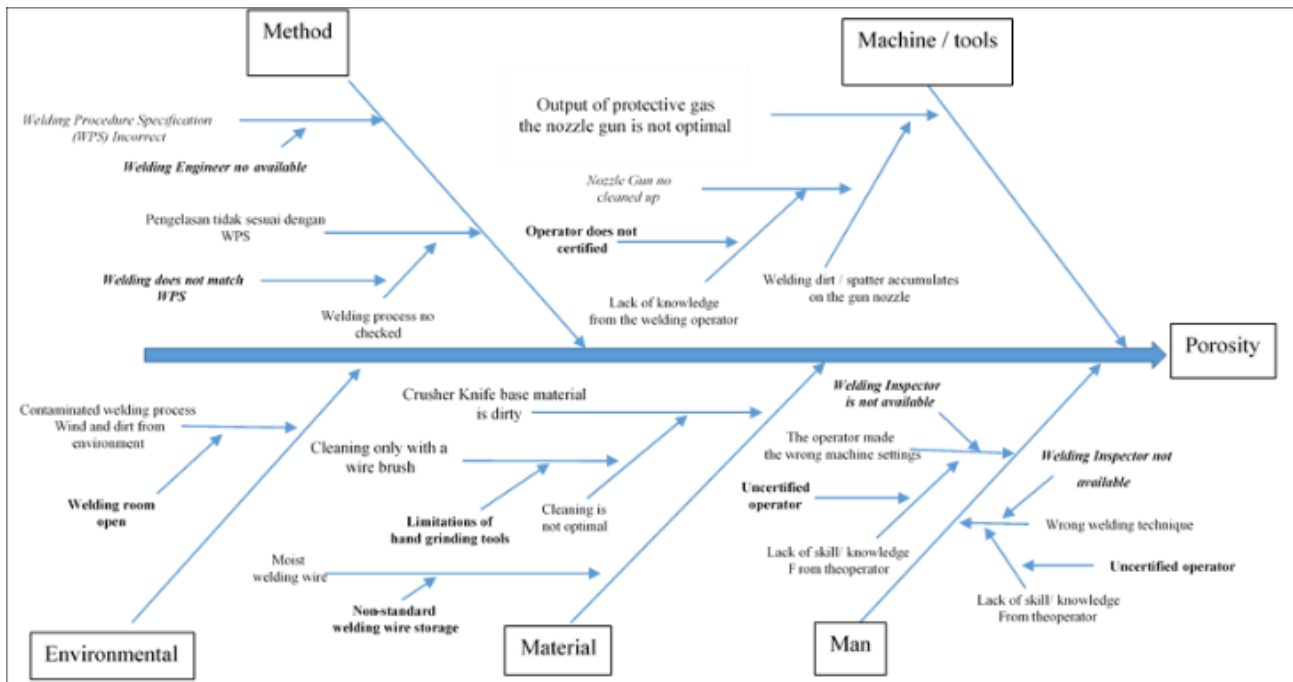


Figure 5: Fishbone Chart

3.4 Corrective of Problem

In this site, the main focus is to take corrective and preventive actions by making ideas for changes to the factors that cause problems that have been obtained in the previous stage.

The length of time for repairs given by companies to make repairs is from January to February 2019. The planning of repairs and time of repairs can be seen in Table 5.

Table 5: Improvement Plan

No	Factor	What	Causes Dominant	How (Solution)	When
1	Man	Wrong operator setting the machine	Welding Inspector not available	Recruiting a Welding Inspector	2020
			Uncertified operator	Conduct external training for welding operators who have not been certified	2020
		Incorrect welding technique	Uncertified operator	Replace Crusher Knife tip welding operators with more experienced and certified operators	January – February 2019
			Welding Inspector is not available	Recruit a Welding Inspector	2020
			Uncertified operator	Conduct external training for welding operators who have not been certified	2020
			Uncertified operator	Replace the Crusher Knife tip welding operator with a more senior and certified operator	January – February 2019
2	Method	Incorrect WPS	Welding Engineer not available	Recruiting a Welding Engineer	2020
		Welding not compatible with WPS	Welding Inspector is not available	Recruit a Welding Inspector	2020
3	Material	Non-standard welding wire storage	There is no adequate storage place for storing welding wire.	There is no adequate storage place for storing welding wire.	January – February 2019
		Crusher Knife base material is dirty	Limitations of hand grinding tools	Buy and provide hand grinders for each welding operator	January – February 2019
4	Machine	The output of the protective gas on the nozzle gun is not optimal	Uncertified operator	Conduct external training to uncertified welding operators	2020
			Uncertified operator	Replace the Crusher Knife tip welding operator with a more senior and certified operator	January – February 2019
5	Environment	Outdoor welding Space	Space limitations in the PT. Andritz Pekanbaru	Changing the position of the welding process from outdoors to indoors.	January – February 2019

In making improvements, some corrective actions can be realized and implemented according to a predetermined schedule, namely:

- Replace crusher knife tip welding operators with more experienced and certified operators.
- Make ovens or cabinets with temperature for the storage of welding wires.
- Buy and supply hand grinders to each welding operator.
- Changing the position of the welding process from outside the room to indoors.

While the corrective actions that cannot be realized according to a predetermined schedule are:

- Recruit a Welding Engineer.
- Recruit a Welding Inspector.
- Conduct external training for welding operators who have not been certified.

4.0 DISCUSSION

4.1 Researching Improvement Results

The defect data after repairs are the occurring of data during the period March 2019 to September 2019. The defect data that occurred after repairs to the crusher knife welding process can be seen in Table 6.

Table 6: Defect porosity percentage and target after repair

Month	Porosity	Total Production	Percentage	Target
March	16	500	3%	10%
April	10	512	2%	10%
May	8	500	2%	10%
June	11	500	2%	10%
July	14	500	3%	10%
August	12	495	2%	10%
Sept.	12	500	2%	10%

PT. Andritz Pekanbaru as a whole provides a target of 10% repair process. As shown in Table 6 above, it can be seen that the defect rate of the Crusher Knife reconditioning process found during the period March to September 2019 is below 10%. The comparison graph of percentage reduction in the Crusher Knife reconditioning process before repairing and after repairing is shown in Figure 6.

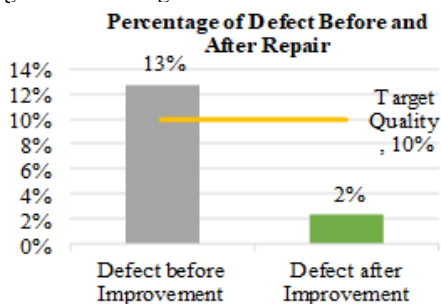


Figure 6: Defect of porosity comparison chart, before and after improvement

In Figure 6 shows a comparison chart of the results of the Crusher Knife reconditioning defect process before and after experiencing improvements based on the average percentage of

total production. Can be seen the percentage of defect porosity that occurred before the repair is 13% which exceeds the target defect target set by PT. Andritz Pekanbaru is 10%. While the defect porosity that occurs after the improvement of 2% where the amount is below the target set by the company that is 10%. The reduction in defect porosity occurs as much as 11% and it can be concluded that improvements were made previously to reduce the amount of defect porosity in the Crusher Knife reconditioning process.

4.2 New Standardization

To keep the Crusher Knife reconditioned products from being defeated again, a standardization process is carried out. Standardization done is:

- The welding operators for Crusher Knife reconditioning must be certified.
- Cleaning with a hand grinding on the Crusher Knife tip section.
- Store the welding wire in the welding wire storage cabinet.
- Welding in the room.

4.3 Next Plans

After completing the PDCA cycle (Plan, Do, Check, Action), the management group of PT. Andritz Pekanbaru continues to make other improvements or what is commonly called continuous improvement. In this last step, implementing the improvement plan that has not been realized in the repair period, namely:

- Recruit a Welding Engineer.
- Recruit a Welding Inspector.
- Conduct external training for welding operators who have not been certified.

5.0 CONCLUSION

Based on the results of discussions that have been carried out at PT. Andritz Pekanbaru, there are several conclusions that can be drawn, namely: the most number of defects in the crusher knife reconditioning process is the type of porosity damage. Then, the improvements or standardization made are: the welding operators for crusher knife reconditioning must be certified; cleaning with a hand grinding on the crusher knife tip section; store the welding wire in the welding wire storage cabinet and welding may in the room. The percentage of defect porosity that occurs before repair is 13%, which exceeds the target defect set by PT. Andritz Pekanbaru that is 10%. While the defect of porosity occurs after the improvement of 2%. This amount is below the target set by the company that is 10%. The reduction in defect porosity occurs as much as 11%. It can be concluded successfully improvements were made to reduce the amount of defect porosity in the crusher knife reconditioning process.

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