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Increasing Productivity of the Welding Process on the H-Beam Production Line by Approach RCA (Root Cause Analysis) at Pt. XYZ

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Abstract:- This research was conducted at a company operating in the construction sector in Cikarang. The researcher conducted direct research on the welding process. The main process of focus in this research is on welding quality defects of the Slag Inclusion type. After knowing the main problem that is the cause of a defect, then carry out an improvement plan using the Root Cause Analysis (RCA) method, which is a method of repairing causal factors by analyzing what, how, and why a factor that causes a defect can occur with the aim of finding the root cause so that There needs to be changes to avoid errors. The RCA method has 2 approaches, namely the Fishbone diagram and 5 whys. Therefore, the author took the title "Increasing the Productivity of the Welding Process in the H-beam Production Line Using the RCA (Root Cause Analysis) Approach at Pt. XYZ" Root Cause Analysis (RCA) is a tool designed to understand the root cause of an event's problems based on causality in a process. The main factor that causes defects is humans who are careless when working, who do not see or observe the material when they want to start work or even underestimate the work. So implementing SOPs is very necessary to regulate workers so they don't work as they please, and outdated machines can hamper production and improve the quality of main raw materials.

Keywords:- *Defect, Root Cause Analysis, RCA, Productivity.*

I. INTRODUCTION

Root Cause Analysis (RCA) is a problem solving method used to identify the root cause or cause of a problem, with the aim of finding out the root cause to eliminate or reduce the possibility of the problem occurring. There may be many factors associated with a particular problem, but not all of them will be the root cause. RCA is recognized by many institutions and organizations, as a powerful and accurate tool for finding the root cause of a problem. Major industries already use RCA and all have guidelines and instructions on how to adapt it to their particular industry. Root Cause Analysis (RCA) is a tool that makes it possible for companies to find the root cause of a problem, because finding the root cause of a problem allows manufacturers to learn from it and improve the manufacturing process. The root cause is the origin of a problem. RCA is an analytical process to understand the causal mechanisms behind changes from a desired state to an undesired state, so that problems do not recur. Root Cause Analysis (RCA) requires investigators to look for solutions to ongoing problems and understand the fundamental or underlying causes of the situation and correct them, thereby preventing the same problem from recurring [1] .

In the current era, technology is developing rapidly and advancing in the construction sector, therefore you must be very familiar with the activity of joining metal or what we often call the welding process because it has a major role when repairing metal. Making H-beam steel has several processes and encounters several failures or defects [2] .

The main process of focus in this research is on welding quality defects of the Slag Inclusion type. During welding, there are still many hollow welding products that form in the welding pool in the form of cavity pores filled with gas or residue from burning the electrode, because during the welding process the gas or dirt is unable to come out along with the welding speed. Welding must be of good quality according to standards and specifications, because the connection requires strong strength to support a load such as the H-beam iron connection [3] .

As the number of failures during welding often occur, researchers evaluate the main causes of defects and focus on quality results [4] . After knowing the main problem that is the cause of a defect, then carry out a repair plan using the Root Cause Analysis (RCA) method. The RCA method has 2 approaches, namely the Fishbone diagram and 5 whys [5] . Responding to existing problems at PT. XYZ plans to increase productivity on the H-beam production line. According to Patil and Sutar (2015), supervision is an activity carried out to ensure that production and operational activities are carried out as planned [6] .

A. Quality

According to Juran (1987) explains that quality means product features that meet customer needs and thus provide customer satisfaction. In this sense, the meaning of quality is income-oriented. The goal of such higher quality is to provide greater customer satisfaction and, one hopes, to increase revenue. However, providing more and/or better quality features usually requires investment and therefore usually involves increased costs. Higher quality in this sense is usually "more expensive". Quality means being free from

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deficiencies or free from errors that require rework or that result in failure in the field, customer dissatisfaction, customer claims, and so on. In this sense, the meaning of quality is cost-oriented, and higher quality is usually "cheaper" [1] .

B. Quality Planning

Quality planning is the first stage of the three managerial processes. Planning quality This can likened planning budget or budgeting in process management finance. There is a number of point which must be considered when carrying out quality planning, namely as follows:

- Set quality target.
- Identification Who customer We.
- Determine need from customer.
- Develop product Which in accordance from response customer needs.
- Develop process for produce product features.
- Prove that process capable produce product in condition available operations.

C. Quality Control

Quality control is one way and effort to have product quality as desired with the aim of improving overall product quality. The aim of quality control is to improve product quality and efficiency, to improve and maintain quality according to the desired level of quality, and to save costs.

Quality control is a process used to guarantee a level of quality in a product or service. Quality control is an engineering and management activity, with which we measure the quality characteristics of products, compare them with specifications or requirements and take appropriate corrective action if there is a difference between the actual appearance and the standard. Quality control is important for companies to carry out so that the products produced comply with the standards set by the company or standards set by local or international bodies that manage quality standardization, and of course in accordance with what consumers expect. well, it will have an impact on the quality of the products produced by the company [7] .

D. Quality Improvement

Quality improvement are actions taken to increase product value for customers by increasing the effectiveness and efficiency of processes and activities through the organizational structure. Quality improvement aims to reduce chronic waste which consists of actions such as increasing factory process output, reducing error rates in the field and reducing failures in the field [8] .

E. Problems Encountered

The main problem that often occurs is the discovery of defective products at the Quality Control stage, which causes delays in delivery and increases production costs because products have to be repaired or remanufactured.

F. Data Types and Sources

There are 2 data sources used by the author, namely:

➢ *Primary Data*

Primary data is data that researchers obtain directly from the source. The main purpose of primary data is to answer various research questions that need to be clarified directly.

➢ *Secondary Data*

Secondary data is a type of data that researchers do not collect directly. Examples include scientific papers, company documents, or government documents. In essence, this data contains information that has been collected and compiled by other parties previously.

G. Method of Collecting Data

There are several data collection methods used for this study, namely:

➢ *Observation*

Conducting direct analysis in the field on an object in the environment, either ongoing or still in the stage, using sensing.

➢ *Documents*

The technique of collecting data through documents is where researchers take research sources or objects from documents or records of past events, either in the form of writing, pictures, or monumental works from someone. Can be taken from diaries, life history, biographies, regulations, and so on.

➢ *Interviews*

This is a data collection technique for the process of asking and answering questions verbally that takes place in one direction, so the interviewer asks questions and is answered by the interviewee.

H. Research Purpose

➢ *The Objectives of this Study are as Follows:*

- Identifying existing problems.
- Knowing the main causes of defects.
- Overcoming and resolving problems that occur

II. RESEARCH METHODS

Research success is determined by good and clear research steps, so that it can be easily seen what steps must be taken to achieve the research objectives and process. The methods in this research include: data collection, quality control analysis, problem formulation, and analysis of factors that cause high product defects using RCA [9] . For clearer information, see figure 1.

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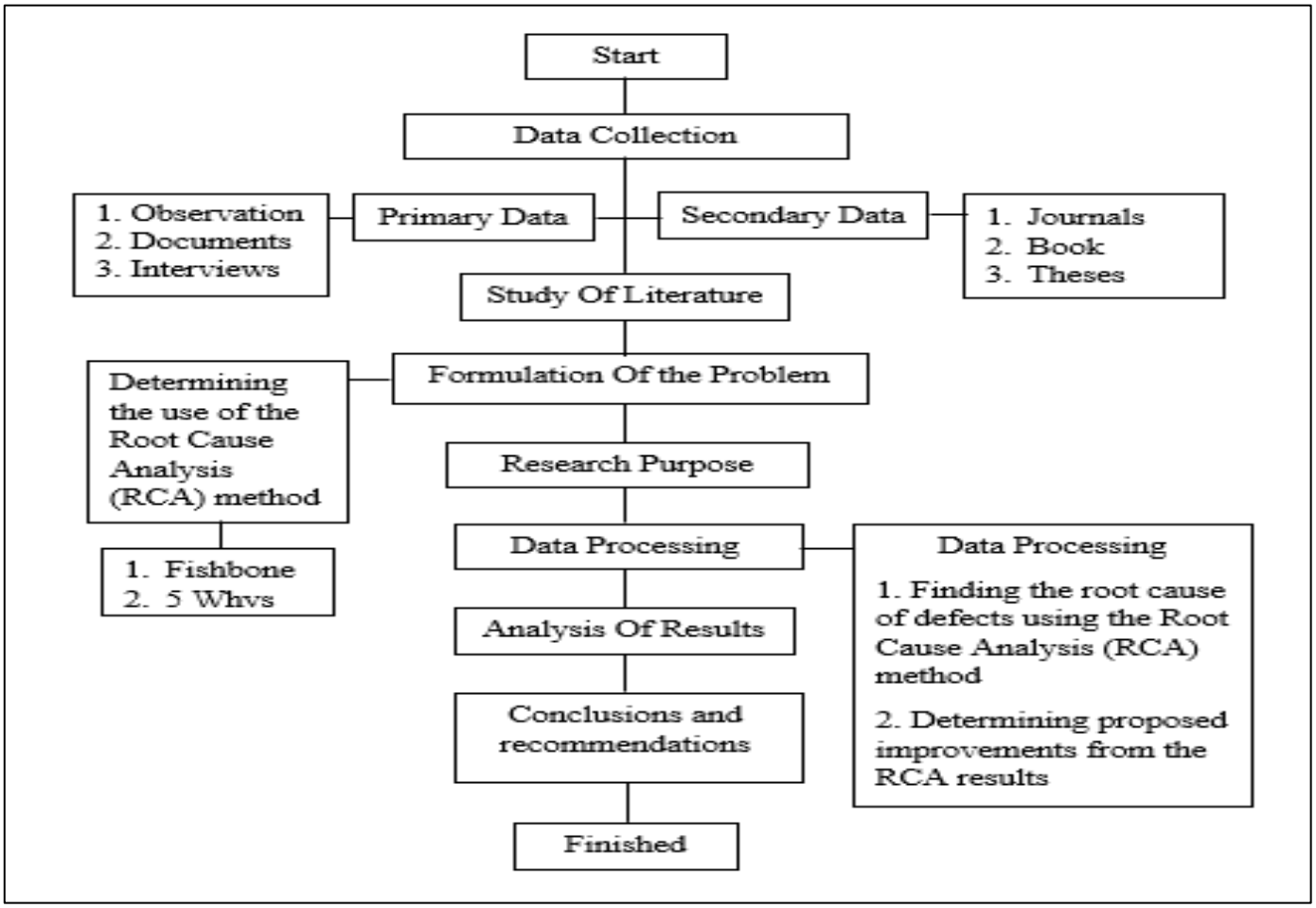

Fig 1: Research Flow Chart

A. Root Cause Analysis (RCA)

Root Cause Analysis (RCA) is a tool designed to understand the root cause of an event's problems based on causality in a process. RCA functions to identify and categorize problems that cause something to happen at an event. In the identification and categorization process, the information explained is not only "what" and "how" but also accommodates "why" an event occurred [10] .

➢ *Fishbone Diagram Tool*

Fishbone diagrams are a visual tool for identifying, exploring, and graphically depicting in detail all the causes related to a problem. The basic concept of a fishbone diagram is that the fundamental problem is placed on the right side of the diagram or at the head of the fishbone framework. The cause of the problem is described in the fins and spines. Categories that cause problems that are often used as an initial start include materials (raw materials), machines and equipment (machines and equipment), manpower (human resources), methods (methods), Mother Nature/environment (environment) and measurement (measurement). These six causes of problems are often abbreviated as 6M. Other causes of the problem besides the 6M can be selected if necessary. To find the causes of problems, whether they originate from the 6Ms as explained above or other possible causes, brainstorming techniques can be used.

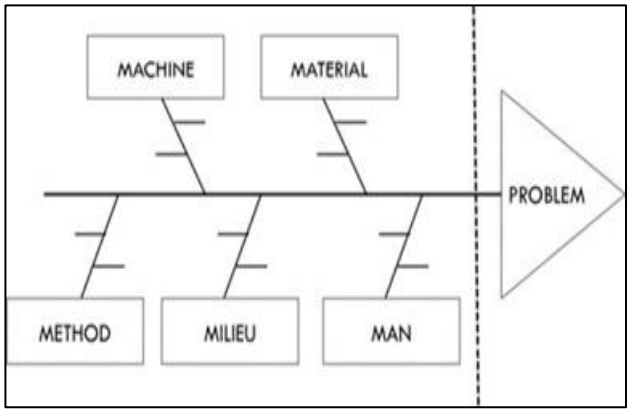

Fig 2: Fishbone Diagrams

➢ *5 Whys Method*

The simplest way to carry out root cause analysis is to ask the question "why" repeatedly 5 times. 5 Why Analysis is a structured approach where asking why questions repeatedly to understand the cause of the problem, and to produce effective corrective actions to reduce the incident, and prevent accidents from happening again. At this stage, the results obtained will continue to be processed in the fishbone diagram stage [11] .

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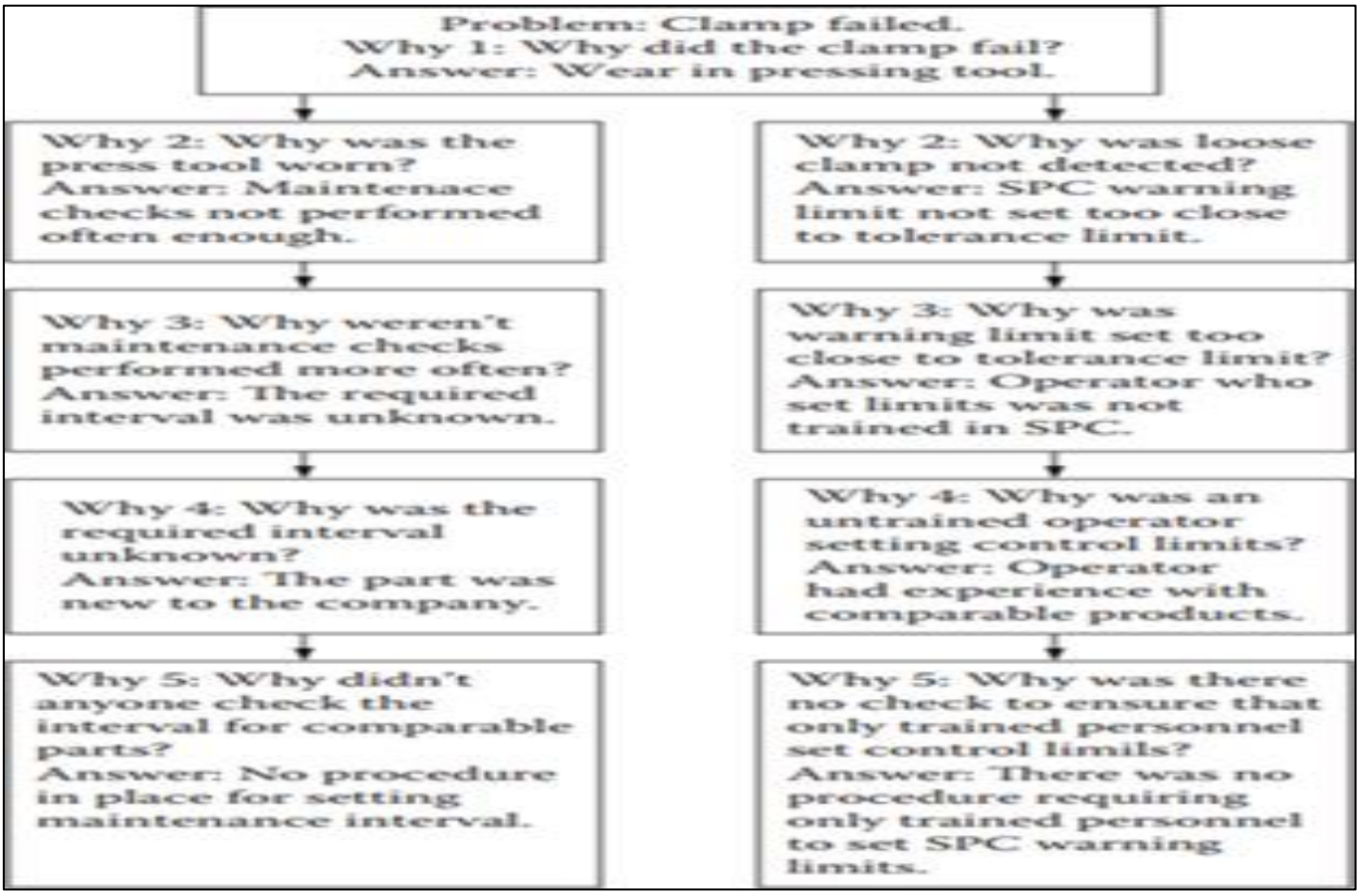

Fig 3: 5 Whys Method

III. ANALYSIS AND DISCUSSION

A. *First Analysis*

The goal to be achieved in this research is efforts to provide recommendations for improvements in reducing defects. Variations in defects found during the welding process can be seen in the following table.

Table 1: Welding Defect Rate in January – March 2024

Month	Welding defects			Percentage (%)
	Number of films	Number of defects	Average type of defect	
January	328	43	Slag inclusion	7.6
February	310	23	Slag inclusion	13.4
March	380	31	Slag inclusion	12.2
Amount	**1018**	**97**		

➢ *Processed Data*

There are a number of variations in defects that occur, it was found that there are 3 types of variations in welding defects.

Table 2: Welding Defect Variations

Month	Type of Defect	Amount
January	Slag Inclusion	22
	Porosity	12
	Incomplete Fusion	9
February	Slag Inclusion	10
	Porosity	5
	Incomplete Fusion	8
March	Slag Inclusion	16
	Porosity	8
	Incomplete Fusion	7

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B. Data Processing

➢ *Fishbone Diagrams*

The analysis was carried out based on the data obtained. The analysis was carried out using the root cause analysis method, the fishbone diagram approach to analyze the causes of the high number of defective products at PT. XYZ. Figure 4 will explain:

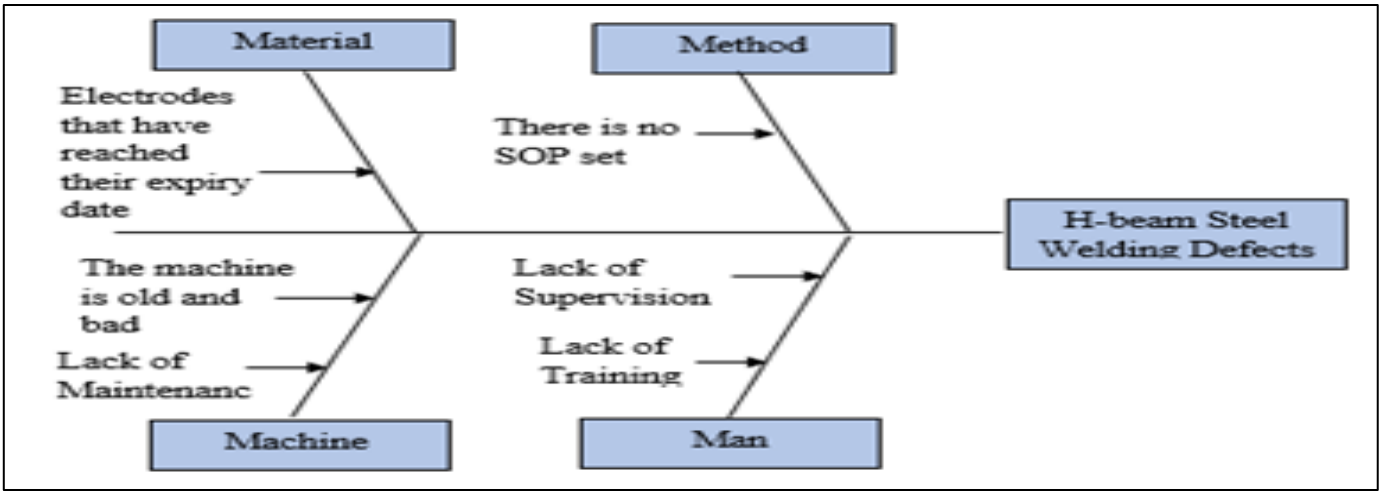

Fig 4: Fishbone Diagrams

➢ *5 Whys Analysis*

From the data collection carried out, it is known that there are four main factors causing potential failure in the welding process, which can be seen in Table 3.

Table 3: Factors Causing Critical Processes

Factor	Factor Name
A	Man
B	Method
C	Machine
D	Material

Source: Data Processing

Table 4: Root Cause Analysis (RCA) 5 whys (Human)

Failure	Why 1	Why 2	Why 3	Why 4	Why 5	Factor
H-beam steel welding defects	Man	Lack of supervision	Lack of training	Employees work casually	Difficulty using the welding machine which often stops	A,C

Source: Data Processing

From the analysis of the table above, the results obtained for the factors that cause failure in welding H-beam steel are human factors, due to lack of supervision and lack of training coupled with employees who work casually, and are faced with welding machines that often break down. So problems occur when welding, and the causal factors during critical processes are humans and machines.

Table 5: Root Cause Analysis (RCA) 5 Whys (Method)

Failure	Why 1	Why 2	Why 3	Why 4	Why 5	Factor
H-beam steel welding defects	Method	There are no SOPs	Lack of team collaboration	Technical errors during the production process	Lack of accuracy during production	A,B,C

Source: Data Processing

From the analysis of the table above, the results obtained for the factors that cause failure in welding H-beam steel are method factors, because there is no SOP implemented. Then it was analyzed again because there was no confirmation within the work team and technical errors in carrying out the production process as well as employees being less careful during the production process. The factors causing the critical process for the failure of cutting uneven wood in making the stern girder seen from the method factor are Human, Method and Machine.

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Table 6: Root Cause Analysis (RCA) 5 whys (Machine)

Failure	Why 1	Why 2	Why 3	Why 4	Why 5	Factor
H-beam steel welding defects	Machine	The machine is outdated and bad	Lack of maintenance	Quality problems	There has been no engine update	A,C

Source: Data Processing

From the analysis of the table above, the results obtained for the factors that cause failure in welding H-beam steel are the factors that the machine used is outdated and bad and lack of maintenance, when defects occur in welding it falls into the poorquality category and because there has been no renewal. machine. And the factors causing the critical process are humans and machines.

Table 7: Root Cause Analysis (RCA) 5 Whys (Material)

Failure	Why 1	Why 2	Why 3	Why 4	Why 5	Factor
H-beam steel welding defects	Material	Electrodes that have reached their expiry date	The raw material is not good in terms of carbon content	It is difficult to find a current controller for electrodes that have expired	Lack of thoroughness and focus	A,B,C,D

Source: Data Processing

From the analysis of the table above, the results obtained for the factors that cause failure in H-beam steel welding are material factors caused by electrodes that have exceeded their expiry date, then the welder finds it difficult to adjust the machine's amperage due to a lack of accuracy and this results in failure of the welding process. And the factors causing the critical process are People, Methods, Machines and Materials.

C. Improvement Recommendations

After the analysis process was carried out using the Root Cause Analysis (RCA) method, it was found that many of the defects that occurred were caused by humans so there were many comparisons. From the results of the data processing above, it was found that there was a lack of training and monitoring for employees as well as the absence of SOPs in the company, especially in the production environment, which caused negligence or no one to regulate them when working. Machines experienced problems in terms of insufficient machine maintenance, which made the machines become quickly damaged and not maintained.

Recommendations for improvement that can be given to this problem are by: (1) Human factors, providing outreach and training about products for employees. Socialization about the product is given when the product will be carried out in the production process, so that employees can know the important points of the product. And holding training for employees with material on the latest production process methods (latest techniques) for a new product (2) Method Factor, implementing Standard Operating Procedures (SOP) so that workers work in accordance with established rules. (3) Machine Factors, recommendations for improvements that must be made are by using more modern machines or other supporting facilities, whether they are truly in standard condition, so that the machine can work according to existing standards. (4) Material Factor, must use higher quality raw materials.

➢ *Fishbone Diagram Analysis*

The results of the analysis of the Fishbone diagram show that the cause of failure in H-beam steel welding is the human factor, lack of training and lack of supervision, the method factor is: making welding SOPs that are useful for control, the machine factor is that the machine used is outdated. and needs replacement, from the material factor, the raw material must be upgraded to a higher quality.

➢ *Analyze the 5 Whys*

The results of the 5 whys analysis show four factors that cause defects in the production process, namely:

- Human factor, due to lack of supervision and lack of training coupled with employees who work casually, and are faced with welding machines that often break down. So problems occur when welding, and the causal factors during critical processes are humans and machines.
- Method factor, because there is no SOP implemented. Then it was analyzed again because there was no confirmation within the work team and technical errors in carrying out the production process as well as employees being less careful during the production process. The factors causing the critical process for the failure of cutting uneven wood in making the stern girder seen from the method factor are Human, Method, and Machine.
- Factors that the machine used is outdated and bad and there is a lack of maintenance, when defects in welding occur it falls into the poor quality category and is due to the lack of updating of the machine. And the factors causing the critical process are humans and machines.
- Material factors caused by electrodes that have exceeded their expiry date and then the welder finds it difficult to adjust the machine's amperage due to lack of accuracy and results in failure of the welding process. And the factors causing the critical process are People, Methods, Machines and Materials

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IV. CONCLUSION

Based on the discussion above, the researcher draws conclusions based on the description of the production process, the failure mode that occurs results in defects of the Slag Inclusion type. From factors without supervision, without applicable Standard Operating Procedures (SOP), without maintenance, and in terms of poor quality materials. The ones that have the biggest impact are the Human, Method, Machine and Material factors. Then corrective actions that must be taken include:

- The need to carry out training and apply work discipline
- Need to enact and implement SOPs
- Need to carry out maintenance on the welding machine and replace parts that should no longer be suitable for use on the machine
- You must always check supporting materials such as electrodes, to avoid something similar happening

RECOMMENDATION

PT. XYZ must supervise employees, as well as carry out training to support the continuity of production. We have to look for alternatives regarding materials and welding machines. It is hoped that after implementing the suggestions above, the company will become even better and can meet the existing qualifications.

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