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Quality Control to Reduce Appearance Defects at PT. Musical Instrument

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Abstract:- This research was conducted at PT. Musical Instruments that aim to analyze quality control to reduce *appearance* defects in piano products on the *assembling* production line. The problem faced by the company is the high level of product defects which has an impact on decreasing quality and customer satisfaction. The research method used is Six sigma with a DMAIC (Define, Measure, Analyze, Improve, Control) approach. This type of research is quantitative, with data collected in the form of the number of production defects in pianos. To analyze the causes of defects, a fishbone diagram with 4M + 1E factors is used, namely Man, Machine, Method, Material, and Environment. The results of the analysis show that the main factors causing appearance defects in piano products include incompatibility with work methods, lack of worker training, use of non-standard materials, suboptimal jig conditions, and unsupportive working environment. Based on these findings, improvement proposals are given in the form of improving standard operating procedures, regular training for workers, the use of high-quality materials, regular maintenance and calibration of jigs, and improvement of work environment conditions. The implementation of this improvement proposal is expected to reduce the number of appearance defects in piano products, improve product quality, and meet the quality standards expected by PT. Musical instrument.

Keywords:- *Quality Control, Appearance Defects, Six Sigma, DMAIC, Fishbone Diagram.*

I. INTRODUCTION

Competition in the industry, both services and manufacturing, is not only on the scale of the company and its human resources but also in the quality of the products produced. Quality is one of the important factors in the business and non-business world, where the good or bad performance of a company can be measured from the quality of the goods and services produced.

In the manufacturing industry, product quality is a crucial factor that determines customer satisfaction and business continuity. Good quality not only reflects the credibility of the company but also affects operational efficiency and production costs. Therefore, many companies are adopting various methods to improve the quality of their products.

One of the most well-known and widely used methods in quality improvement efforts is Six Sigma. Six Sigma is a methodology that focuses on reducing variations and defects in the production process through a structured approach. This methodology aims to achieve a very low defect rate, which is no more than 3.4 defects per million opportunities (DPMO - Defects Per Million Opportunities).

Six Sigma uses five main stages known as DMAIC, namely Define, Measure, Analyze, Improve, and Control. This DMAIC stage is designed to assist companies in identifying, measuring, analyzing, correcting, and controlling quality problems that occur in the production process.

This research was conducted at PT. Musical Instruments, a company engaged in the production of musical instruments. The purpose of this study is to analyze the causes of appearance defects in the products produced and find solutions to improve them. By using the Six Sigma method and DMAIC stages, it is hoped that this study can provide the right recommendations to reduce appearance defects so that the product quality of PT. Musical Instruments can be improved.

Through field observation and comprehensive data analysis, this study will identify the factors that cause defects and provide suggestions for improvement that can be implemented by the company. Thus, the results of this research are expected to contribute to improving product quality and operational efficiency at PT. Musical instrument.

II. LITERATURE REVIEW

A. Quality

According to Prawirosentono (2007: 5), the quality of a product has a different definition because it is seen from two sides, namely the side as a consumer (user of goods and services) and the side as a producer (maker of goods and services). From the manufacturer's perspective, the quality of a product is the physical state, function, and nature of the product in question that can satisfactorily meet the tastes and needs of consumers according to the value of the money that has been spent. And from the consumer side, the quality of a good or service is related to consumer satisfaction in using the goods or services in question. If consumers are satisfied, it means that the quality of the product is good. But if consumers are not satisfied, it means that the quality of the product is poor.

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B. Quality Control

Quality control is a systematic approach used to ensure that the products or services produced meet the set quality standards. In the perspective of industrial engineering, quality control involves the use of special methods and techniques aimed at identifying, preventing, and reducing defects or nonconformities in the production process.

C. Product Appearance

The Apperance field is the area that can be seen on the condition of the final product. Including parts that can be seen by customers, when it is necessary to assemble, disassemble, replace and install are included as the field of appearance. Parts that consumers cannot see during after-sales are not included as appearance fields.

D. Product Defect

Defects are defined as products that are made that do not meet specifications so that they cause rework, scrap, production delays, the need for investigations, and so on. This waste can be caused by product imperfections and lack of labor during the process.

E. Six Sigma

Six sigma is a quality management methodology used in the industry to improve the performance of business processes by identifying and eliminating deviations or defects that may lead to imperfections in a product or service. The main goal of Six sigma is to achieve a high and consistent level of quality in the production or service process by minimizing variability and errors.

F. QC 7 Tools

QC 7 Tools or Seven Basic Tools of Quality is a basic tool used in quality control to solve various problems related to product and process quality. These tools are designed to assist in data collection and analysis, root cause identification, and effective solution implementation. The use of QC 7 Tools is essential in quality control methods because it provides a systematic and structured approach in dealing with quality problems. The included in QC 7 Tools are:

- Cause-and-Effect Diagram
- Pareto Chart
- Flowchart
- Check Sheet
- Histogram
- Scatter Diagram
- Control Chart

These seven tools are often used together to analyze and improve processes, as well as ensure that product quality remains in accordance with the set standards.

III. RESEARCH METHODS

A. Place and Time of Research

This research was carried out at PT. Musical Instruments for a period of three months, from May to July. PT. Musical Instruments is a company engaged in the production of musical instruments and is the location of this research to identify and analyze the causes of defects in the products produced.

B. Data Type

This study uses secondary data obtained from companies in the form of the number of production and the number of defects in products during the research period. This secondary data will be analyzed to find patterns and causes of appearance defects in the product.

C. Data Collection

Data collection in this study was carried out through three main methods:

- *Observation:*

Observation was made by directly observing the production process at PT. Musical instrument. Researchers note various aspects that can affect product quality, such as machine conditions, operator behavior, and work environment. This observation aims to get a clear picture of the production process and the factors that can cause defects in the product.

- *Documentation:*

Documentation is done by collecting data that already exists in the company. This data includes the number of production and the number of product defects recorded during a given period. In addition, other relevant documents such as quality reports, work procedures, and machine maintenance records are also collected for analysis.

- *Literature Studies:*

Literature studies are carried out by researching literature that is relevant to the research topic. Books, scientific journals, articles, and other sources discussing quality, Six Sigma, and DMAIC will be used to strengthen the theoretical foundation of this research. Literature studies also help in understanding the proper methods of analysis and identifying best practices in addressing quality issues.

D. Data Analysis

To analyze the data that has been collected, this study uses the Six Sigma approach with DMAIC stages. Here is a full explanation of DMAIC:

- *Define :*

This first stage aims to define the problem to be solved. At PT. Musical Instruments, the problem faced is the high level of appearance defects in the product. At this stage, the objectives and scope of the improvement project are also determined, as well as the identification of customers and their needs.

- *Measure :*

At this stage, data on the number of production and the number of defects are collected and measured. Measurements are taken to get an accurate picture of the current conditions. This data will be used as a basis to analyze the causes of defects and evaluate the effectiveness of the repairs made.

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➢ *Analyze :*

The data that has been collected is then analyzed to identify the root cause of the defect. The analysis was carried out using various statistical and qualitative tools such as pareto charts, fishbone diagrams, and regression analysis. The goal of this stage is to find the main factors that cause appearance defects in the product.

➢ *Improve :*

Once the root cause of the defect is identified, corrective measures are designed and implemented. These improvements can include changes to production processes, operator training, or machine maintenance. The goal of this stage is to reduce or eliminate the cause of defects so that the quality of the product improves.

➢ *Control:*

This last stage aims to ensure that the improvements that have been made can be maintained in the long term. Control is carried out by implementing standard procedures, conducting routine monitoring, and using quality control tools such as control charts. Thus, the quality of the product can be maintained and the improvements that have been achieved can be maintained.

Through the application of DMAIC, this research is expected to provide an effective solution to reduce appearance defects in PT. Musical Instruments and improve the overall quality of the production process.

IV. RESULTS AND DISCUSSION

Defect data on the piano production process at PT. Musical Instruments during the month of May – July 2023

Table 1 Production Quantity

Moon	Production Quantity (units)	Number of Defects in the Piano Production Process
May	1050	99
June	1045	117
July	1055	102
Total	3150	318

After obtaining the data, then process the data obtained so that the problems that occur can be known for quality improvement using the DMAIC stages.

A. Define

The problem that occurred in this study was the number of product defects that occurred in the finishing process in the piano assembling section. Some of the defects that occur include scratches, sunholes, bubbles, dirty and lumps.

The following is data on the number of defective products that occur in the production process of making pianos at PT. Musical Instruments during the month of May – July 2023.

Table 2 The Number of Each Defect

Types of Defects	Month			Total of Defect
	May	June	July	
Stratch	40	47	43	130
Sunken	18	21	15	54
Bubble	13	18	15	46
Dirty	19	26	23	68
Lumpy	9	5	6	20
Total	99	117	102	318

From the table above, it can be seen that there are 5 types of defects which are quite a lot. Therefore, improvements are needed to reduce these defects.

B. Measure

At this stage, measurements are made of the types of defects that have been identified. To determine the measurement, a Critical to Quality (CTQ) determination will be carried out and calculate the sigma level of the defect level per million DPMO opportunities.

➢ *Penentuan Critical to Quality (CTQ)*

In the selection of CTQ, it is based on the type of defect that is the most dominant or has the greatest influence on product quality. This most dominant type of defect will be the main problem that will be addressed to obtain improvement.

- *Calculating the Percentage of Defect Types*

The data processed to determine the percentage of product defects with the formula:

$$\%\text{Defective} \quad = \text{x } 100\% \frac{\text{Certain number of defects}}{\text{total number of defects}}$$

Below is an example of the calculation of the percentage of scratch defects

$$\text{Disability} \quad = \frac{130}{318} \text{ x } 100\% = 40.88\% \text{ (rounded to 41\%).}$$

The calculation of other types of defects uses the same formula, as outlined in the following table

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Table 3 Defect Percentage

No	Types of Defects	Number of Defects	Percentage	Cumulative defects
1.	Scratch	130	40,88%	40,88%
2.	Dirty	68	21,38%	62,26%
3.	Sunken	54	16,98%	79,24%
4.	Bubble	46	14,46%	93,7%
5.	Lumpy	20	6,28%	100,00%
Total		318	100.%	

- *Create a Pareto Diagram*

Based on the calculation results from Table 3, a pareto diagram can be depicted which can be seen in the figure.1.

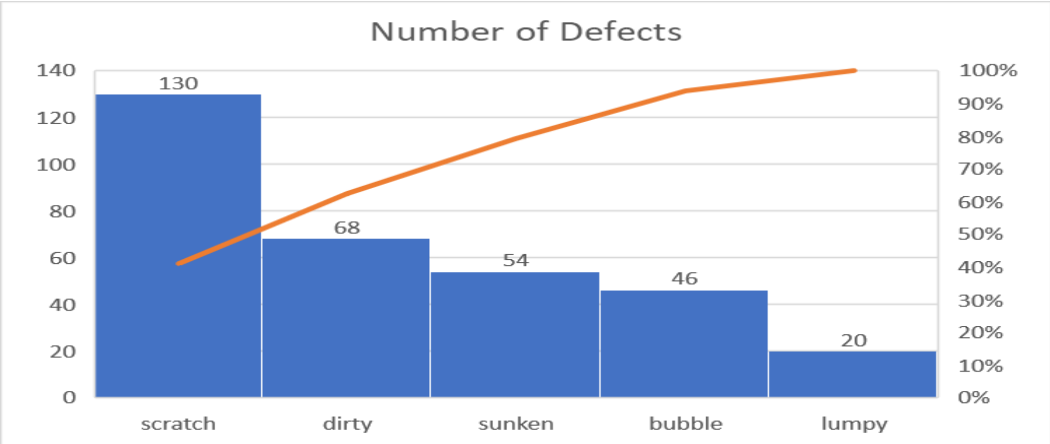

Fig 1 Diagram Pareto

From the pareto diagram above, it can be seen that the most common type of defect from May – July is scratch defect with a total of 130 or 40.8%. Therefore, it is necessary to analyze the causes and find improvement solutions to reduce these defects.

- *Control Map*

The control map used in this study is a p-control map or p-chart, because the p-control map is used to monitor the proportion of defective units of the total units in the sample over time.

The following is the data on scratches that occur in the piano production process.

Table 4 Number of Scratch Defects

Date of Observation	Production Amount (n)	Number of Scratch Defects
2-May-23	50	1
3-May-23	50	2
4-May-23	50	4
5-May-23	50	2
8-May-23	50	2
9-May-23	50	2
10-May-23	50	4
11-May-23	50	2
12-May-23	50	3
15-May-23	50	0
16-May-23	50	1
17-May-23	50	0
19-May-23	50	4
22-May-23	50	1
23-May-23	50	1
24-May-23	50	2
25-May-23	50	0
26-May-23	50	3
29-May-23	50	3
30-May-23	50	2

31-May-23	50	1
02-Jun-23	50	2
04-Jun-23	50	3
05-Jun-23	50	2
06-Jun-23	50	1
07-Jun-23	50	0
08-Jun-23	50	4
09-Jun-23	50	2
12-Jun-23	50	2
13-Jun-23	50	4
14-Jun-23	50	0
15-Jun-23	50	0
16-Jun-23	50	4
19-Jun-23	50	3
20-Jun-23	50	4
21-Jun-23	50	1
22-Jun-23	50	2
23-Jun-23	50	3
26-Jun-23	50	4
27-Jun-23	50	2
28-Jun-23	47	3
30-Jun-23	48	1
03-Jul-23	55	3
04-Jul-23	50	4
05-Jul-23	50	1
06-Jul-23	52	1
07-Jul-23	53	4
10-Jul-23	56	2
11-Jul-23	50	3
12-Jul-23	55	2
13-Jul-23	50	2
14-Jul-23	53	3
17-Jul-23	50	0
18-Jul-23	53	3
20-Jul-23	55	3
21-Jul-23	54	1
24-Jul-23	52	4
25-Jul-23	55	2
26-Jul-23	55	2
27-Jul-23	52	0
28-Jul-23	50	2
31-Jul-23	55	1
Total	3150	130

- *Calculating the defect proportion (P1)*

The calculation of the defect proportion of scratch defects uses the following formula:

$$P1 = \frac{np1}{n1} = \frac{1}{50} = 0{,}0200$$

$$P2 = \frac{np2}{n2} = \frac{2}{50} = 0{,}0400$$

For other data calculations carried out with the same formula, the results of the calculation can be seen in table 5.

- *Calculating the limit of control (UCL and LCL)*

$$\bar{p} = \ = 0{,}04126984 = \frac{\sum np}{\sum n}\frac{130}{3150}$$

Therefore, CL (Center Line) = p¯= 0.04126984

Next, to calculate UCL (Upper Control Limit) using the formula:

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

The UCL calculation on May 2, 2024 is as follows:

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

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UCL = $0{,}04126984 + 3\sqrt{\frac{0{,}04126984(1-0{,}04126984)}{50}}$

UCL = 0,0125721

The LCL calculation on May 2, 2024 is as follows:

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

LCL = $0{,}04126984 - 3\sqrt{\frac{0{,}04126984(1-0{,}04126984)}{50}}$

LCL = 0,043121

For the calculation of other observation data is carried out with the same formula, the calculation results can be seen in table 5.

Table 5 Control Map Table

Date of Observation	Production Amount (n)	Number of Scratch Defects	Defect Proportion (P)	CL = p bar	UCL	LCL
2-May-23	50	1	0,0200	0,041270	0,125721	-0,043121
3-May-23	50	2	0,0400	0,041270	0,125721	-0,043121
4-May-23	50	4	0,0800	0,041270	0,125721	-0,043121
5-May-23	50	2	0,0400	0,041270	0,125721	-0,043121
8-May-23	50	2	0,0400	0,041270	0,125721	-0,043121
9-May-23	50	2	0,0400	0,041270	0,125721	-0,043121
10-May-23	50	4	0,0800	0,041270	0,125721	-0,043121
11-May-23	50	2	0,0400	0,041270	0,125721	-0,043121
12-May-23	50	3	0,0600	0,041270	0,125721	-0,043121
15-May-23	50	0	0,0000	0,041270	0,125721	-0,043121
16-May-23	50	1	0,0200	0,041270	0,125721	-0,043121
17-May-23	50	0	0,0000	0,041270	0,125721	-0,043121
19-May-23	50	4	0,0800	0,041270	0,125721	-0,043121
22-May-23	50	1	0,0200	0,041270	0,125721	-0,043121
23-May-23	50	1	0,0200	0,041270	0,125721	-0,043121
24-May-23	50	2	0,0400	0,041270	0,125721	-0,043121
25-May-23	50	0	0,0000	0,041270	0,125721	-0,043121
26-May-23	50	3	0,0600	0,041270	0,125721	-0,043121
29-May-23	50	3	0,0600	0,041270	0,125721	-0,043121
30-May-23	50	2	0,0400	0,041270	0,125721	-0,043121
31-May-23	50	1	0,0200	0,041270	0,125721	-0,043121
02-Jun-23	50	2	0,0400	0,041270	0,125721	-0,043121
04-Jun-23	50	3	0,0600	0,041270	0,125721	-0,043121
05-Jun-23	50	2	0,0400	0,041270	0,125721	-0,043121
06-Jun-23	50	1	0,0200	0,041270	0,125721	-0,043121
07-Jun-23	50	0	0,0000	0,041270	0,125721	-0,043121
08-Jun-23	50	4	0,0800	0,041270	0,125721	-0,043121
09-Jun-23	50	2	0,0400	0,041270	0,125721	-0,043121
12-Jun-23	50	2	0,0400	0,041270	0,125721	-0,043121
13-Jun-23	50	4	0,0800	0,041270	0,125721	-0,043121
14-Jun-23	50	0	0,0000	0,041270	0,125721	-0,043121
15-Jun-23	50	0	0,0000	0,041270	0,125721	-0,043121
16-Jun-23	50	4	0,0800	0,041270	0,125721	-0,043121
19-Jun-23	50	3	0,0600	0,041270	0,125721	-0,043121
20-Jun-23	50	4	0,0800	0,041270	0,125721	-0,043121
21-Jun-23	50	1	0,0200	0,041270	0,125721	-0,043121
22-Jun-23	50	2	0,0400	0,041270	0,125721	-0,043121
23-Jun-23	50	3	0,0600	0,041270	0,125721	-0,043121
26-Jun-23	50	4	0,0800	0,041270	0,125721	-0,043121
27-Jun-23	50	2	0,0400	0,041270	0,125721	-0,043121
28-Jun-23	47	3	0,0638	0,041270	0,128374	-0,045774
30-Jun-23	48	1	0,0208	0,041270	0,127462	-0,044862
03-Jul-23	55	3	0,0545	0,041270	0,121793	-0,039193
04-Jul-23	50	4	0,0800	0,041270	0,125721	-0,043121
05-Jul-23	50	1	0,0200	0,041270	0,125721	-0,043121

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06-Jul-23	52	1	0,0192	0,041270	0,124082	-0,041482
07-Jul-23	53	4	0,0755	0,041270	0,123297	-0,040697
10-Jul-23	56	2	0,0357	0,041270	0,121071	-0,038471
11-Jul-23	50	3	0,0600	0,041270	0,125721	-0,043121
12-Jul-23	55	2	0,0364	0,041270	0,121793	-0,039193
13-Jul-23	50	2	0,0400	0,041270	0,125721	-0,043121
14-Jul-23	53	3	0,0566	0,041270	0,123297	-0,040697
17-Jul-23	50	0	0,0000	0,041270	0,125721	-0,043121
18-Jul-23	53	3	0,0566	0,041270	0,123297	-0,040697
20-Jul-23	55	3	0,0545	0,041270	0,121793	-0,039193
21-Jul-23	54	1	0,0185	0,041270	0,122535	-0,039935
24-Jul-23	52	4	0,0769	0,041270	0,124082	-0,041482
25-Jul-23	55	2	0,0364	0,041270	0,121793	-0,039193
26-Jul-23	55	2	0,0364	0,041270	0,121793	-0,039193
27-Jul-23	52	0	0,0000	0,041270	0,124082	-0,041482
28-Jul-23	50	2	0,0400	0,041270	0,125721	-0,043121
31-Jul-23	55	1	0,0182	0,041270	0,121793	-0,039193
Total	3150	130				

- *Control Map Graph P*

After doing calculations to look for UCL and LCL, the data is then analyzed to find out the extent of the defective product, whether it is still within the control limit or not. The calculation is evidenced by a control map graph p on the image which is useful for providing input on when and where the company should make improvements.

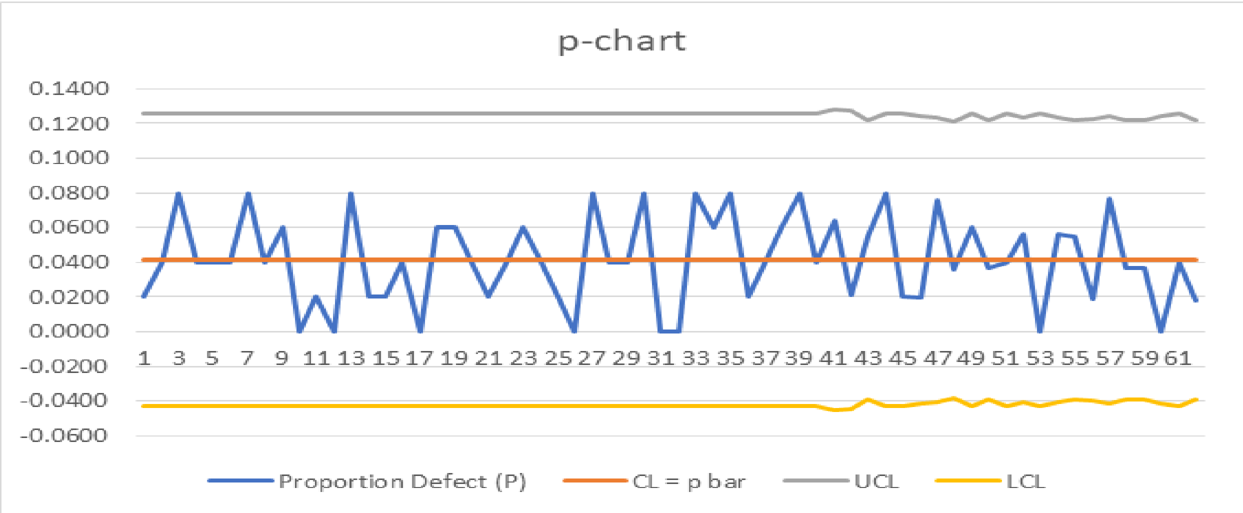

Fig 2 P Control Map

➢ *DPMO and Sigma Level Measurements*

- *DPMO Calculation*

✓ *Unit*

The number of piano production in May – July is 3150 units.

✓ *Opportunities (OP)*

Based on CTQ calculations, the type of defect that greatly affects product damage is scratch defects.

✓ *Defect (D)*

The number of defects that occurred in the piano production process during May – July was 318 units.

✓ *Defect Per Unit (DPU)*

Defect Per Unit can be calculated by the formula:

$$DPU = \frac{D}{U}$$

= 318/3150

= 0,100952381

✓ *Total Opportunities (TOP)*

Total Opportunities can be calculated by the formula:

TOP = Unit (U) x Opportunities (OP)

= 3150 x 1

= 3150

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✓ *Defect Per Opportunities (DPO)*

Defect Per Opportunities (DPO) can be calculated by the formula:

$$DPO = \frac{D\ (Defect)}{TOP\ (Total\ Opportunities)}$$

$$= 318/3150$$

$$= 0{,}100952381$$

✓ *Defect Per Million Opportunities (DPMO)*

The DPMO value can be calculated by the formula:

DPMO = Defect Per Opportunities (DPO) x 10^6

= 0,100952381 x 10^6

= 100952

Based on the results of these calculations, it is known that the number of defects in one million production opportunities is 100,952 units.

- *Sigma Level Calculation*

Based on the sigma conversion table, the DPMO value of 100.952 is at the level of 2.77 – 2.78. So to find out the sigma level of the company is carried out by interpolation, where the DPMO value is 2.77 = 102,042 and 2.78 = 100,273, the following calculation is required:

$$\frac{102.042 - 100.952}{100.952 - 100.273} = \frac{2{,}78 - x}{x - 2{,}77}$$

$$\frac{1090}{679} = \frac{2{,}78 - x}{x - 2{,}77}$$

$$1090\ (x – 2{,}77) = 679\ (2{,}78 – x)$$

$$1090x – 3019{,}3 = 1887{,}62 – 679x$$

$$1090x + 679x = 1887{,}62 + 3019{,}3$$

$$1769x = 4{,}906.92$$

$$x = 4.906{,}92 / 1769$$

$$x = 2.77$$

From the results of these calculations, it was found that the company's sigma level for the piano production process is currently at the level of 2.77.

➢ *Analyze*

After the type of defect that occurs is known, the cause of the defect is searched using a why why analysis which is then made a causal diagram or fishbone diagram. The following is a table of why why analysis of scratch defect problems. It can be seen in table 6.

Table 6 Why Why Analysis

Problem that happen	Why 1	Why 2	Why 3	Why 4	Why 5
Scratch Products	The material is already defective from the previous process	The operator does not check the material at the beginning of the process	Operators are unaware of the importance of material checking	SOPs do not require material checks at the beginning of the process	SOPs have not been updated with the latest inspection standards

From the why analysis table, it is then poured into a *fishbone diagram.* The cause-and-effect diagram shows the factors that cause product damage. The use of the cause-and-effect diagram in this study is to find the cause of damage caused by humans, production facilities, methods and materials and the type of damage that has occurred. Of the types of defects that occur, the most common defects are scratch defects. Then the fishbone diagram of the scratch defect is as follows

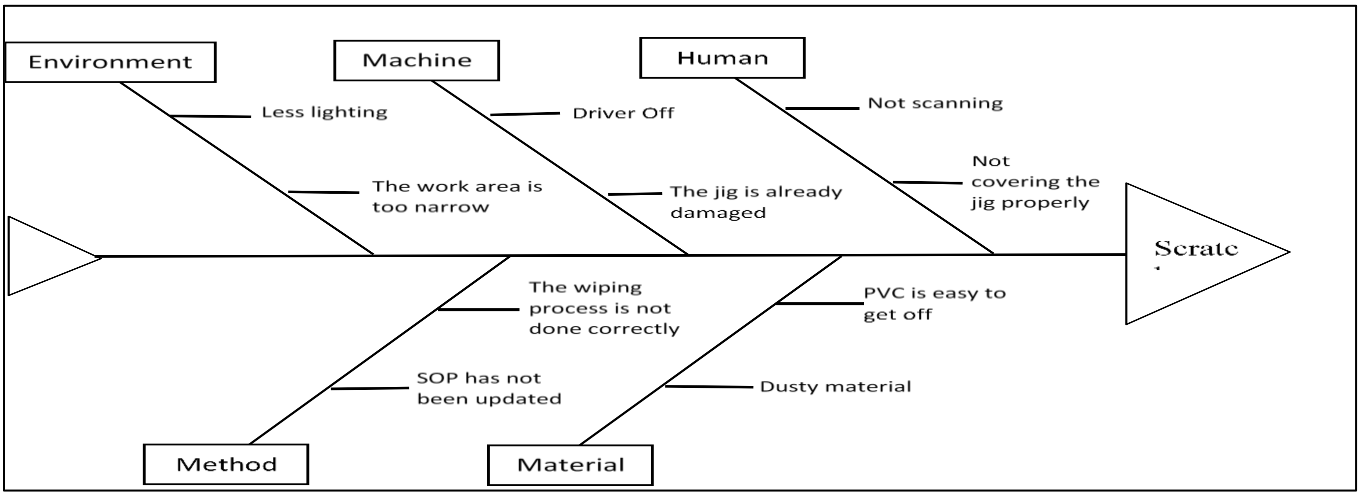

Fig 3 Fishbone Diagram

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From the causal diagram above, it can be seen that there are factors that cause defects in the product. The factors that cause defective products are as follows:

- *Human*

The role of the assy operator is very influential in the factors that cause product defects. The high level of efficiency forces operators to work quickly, often ignoring critical processes such as scanning materials to avoid material defects. This scanning allows the separation of defective material to a special rack prior to the assy process. In addition, operators often underestimate the importance of changing the wipes every hour to prevent dust on the wipes from causing defects such as scratches and dirt on the material.

- *Material*

Wood materials, especially those that are bright in color such as white, are easily dirty and imprint when held and are prone to being scratched by the operator's gloves during scanning. In addition, the material rack from the previous process is often dusty. To minimize this problem, the operator is obliged to replace gloves that are already dirty or rough.

- *Machine*

Jigs and screw drivers (air drivers and electric drivers) that exceed the validation period often cause scratch defects in the material. This is caused by the cover or felt on the jig being damaged, so that the material comes into direct contact with the wooden jig.

- *Method*

The wiping of the material by the assy operator is good, but many scratch defects are found after the assy process due to friction with the jig. To prevent this from happening, cleaning and scanning are carried out at the beginning and end of the process.

- *Environment*

After analysis, the illumination in the scanning and wiping area was below the standard of 1200 lux, only reaching 1100 lux. This results in the scanning process not being optimal and scratch defects are not visible. In addition, the narrow work area often causes the material to be stuck on the workbench, resulting in material defects.

➢ *Improve*

Improve is an action plan to improve the quality of six sigma. Proposals for improvements to reduce product defects in pianos are outlined by the following 5W+1H method:

Table 7 5W+1H Table

Factor	**What**	**Why**	**Where**	**When**	**Who**	**How**
Man	Operator negligence	Lack of training	Line Assembling	During the production process	Production operators	Provide additional training and strict supervision
	Unfocused operator	High production targets	Line Assembling	During the production process	Production Operator	Motivate employees
Material	The material from the process before there were many scratches	Use of shelves that have been damaged	Area transit material	Before the production process	PIC material handling	Checking the material every time the material comes in
	Dusty material from the process before	Rak material kotor	Area transit material	Before the production process	PIC material handling	Spraying and cleaning of shelves before being taken to the assembling area
Method	No material drying process	There is no updated SOP on the cleaning process	Line Assembling	During the production process	Production operators	SOP updated by adding a cleaning process
Machine	There is a peeling cover on the jig	Maintenance jig past the due date	Line Assembling	During the production process	Production operators	Perform jig maintenance after the set schedule

Based on the results of the repair plan carried out using the 5W+1H method, the proposed improvements that can be made to reduce the number of scratch defects in the piano production process are by providing retraining to operators and providing motivation to do work according to instructions, making SOPs for embezzlement standards, performing maintenance jigs according to schedule, conducting regular inspection of lighting standards and doing 5S in the work area.

➢ *Control*

Although this research is limited to the Improve stage, a proposed control plan needs to be prepared to ensure that the improvements that have been made can be maintained and improved. Here are the proposed control plans:

- *SOP Implementation*

New SOPs will be developed and implemented to ensure consistency in the production process. This SOP will include new measures that have been implemented during the Improve phase.

- *Training and Education*

Employees and operators will receive training on process changes and the importance of adhering to the new SOPs. This training will be conducted periodically to ensure a thorough understanding.

- *Periodic Audits and Inspections*

Periodic audits and inspections will be scheduled on a monthly basis to ensure that processes remain in accordance with the control plan. The results of the audit will be documented and analyzed for further improvement.

V. CONCLUSION

Based on the results of the research and analysis carried out, several conclusions can be drawn as follows:

- Defining quality problems with the six sigma method on piano products there are 5 defects that cause products in the Not Good category, namely scratches as much as 41%, dirty as much as 21%, concave sebsnysk 17%, bubbles 14% and gompal as much as 6%.
- Based on measurements using CTQ and pareto diagrams, there is a defect that has the most influence on product quality is a scratch defect with a DPMO value of 100.952 at the level of 2.77 sigma. Therefore, in reducing the level of defects, companies must be more careful in analyzing the causes of defects in a production process.
- In the analysis of the cause of defects, a fishbone diagram or causal diagram is made. Based on the fishbone, there are factors that cause defects from human, material, method, machine, and environmental factors.
- Proposed improvements recommended to companies to reduce scratch defects include the following:

✓ *Human Factors:*

- Conducting stricter supervision of operators
- Pemberian training
- Motivating operators

✓ *Engine Factor*

- Make a check sheet for the initial check of the jig
- Jig sprayed before process
- Regular cleaning of the jig cover

✓ *Method Factors*

- Cleansing is done at the beginning of the process and at the end of the process
- Changes in PPK (work attention points)

✓ *d. Material Factors*

- Checking the material every time the material comes in
- Spraying of material racks by handling operators before being flowed to the final section assy
- Separating good materials from damaged ones with NG labels
- Environmental Factors
- Periodic inspections are carried out regarding lighting levels
- 5S activity 10 minutes before going home
- Briefing on the importance of maintaining environmental cleanliness in the factory area

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