Statistical Quality Control (SQC) Method Analysis Regarding Qualty Control of Shoe Products (Case Study of PT-X)

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ABSTRAK

Industri sepatu berperan penting dalam perekonomian dengan produksi massal, menciptakan persaingan ketat. Perusahaan perlu merencanakan produksi secara matang untuk memenuhi permintaan pasar. Observasi menunjukkan adanya cacat produksi yang menurunkan kinerja dan menimbulkan kerugian, terutama dalam distribusi. Penelitian ini menggunakan Analisis P-Chart untuk memantau proporsi produk cacat, bertujuan mendeteksi kesalahan sebelum penjualan. Penerapan metode pengendalian kualitas melalui Statistical Quality Control (SQC) diusulkan. Diagram Pareto mengidentifikasi jenis kerusakan utama: over cementing (35,9%), open bonding (27,7%), overlay (24,1%), damage material metal (6,3%), dan damage material (6,1%). Analisis P-Chart menemukan titik di luar batas kendali pada data ke-15 dan ke-18, yang dihapus untuk stabilisasi sampel. Analisis fishbone membantu mengidentifikasi penyebab masalah. Over cementing, open bonding, dan overlay disebabkan oleh faktor manusia, material, dan mesin. Damage material dan metal material juga disebabkan oleh faktor manusia, material, dan mesin, serta faktor metode. Penelitian ini menunjukkan pentingnya penerapan kontrol kualitas untuk mengurangi cacat produksi dan meningkatkan kinerja perusahaan.

Kata kunci: Pengendalian Mutu; Metode Pengendalian Mutu Statistik (SQC)

ABSTRACT

The shoe industry plays an important role in the economy with mass production, creating fierce competition. Companies need to plan production carefully to meet market demand. Observations show that there are production defects that reduce performance and cause losses, especially in distribution. This research uses P-Chart Analysis to compare the proportion of defective products, aiming to detect errors before sale. The application of a quality control method through Statistical Quality Control (SQC) is proposed. The Pareto diagram identifies the main types of damage: over cementing (35.9%), open bonding (27.7%), overlay (24.1%), metal material damage (6.3%), and material damage (6.1 %). P-Chart analysis found points outside the control limits in the 15th and 18th data, which were removed for sample stabilization. Fishbone analysis helps identify the cause of the problem. Over cementing, open bonding, and overlay are caused by human, material, and machine factors. Damage to metal materials and materials is also caused by human, material and machine factors, as well as method factors. This research shows the importance of implementing quality control to reduce production defects and improve company performance.

Keywords: *Quality Control; Statistical Quality Control Method (SQC)*

INTRODUCTION

The shoes industry in Indonesia has experienced significant development. According to the Director General of Small and Medium Industries (IKM) of the Ministry of Industry, Euis Saedah, the shoe manufacturing industry is one of the sectors experiencing rapid growth in Indonesia. Currently, the shoe industry plays an important role in the country's economic growth by being able to produce shoes in large quantities. With so many shoe companies developing in Indonesia, competition between companies to win market share is increasing. Therefore, every company needs to plan their production carefully to meet market demand.

Production planning is the most important thing in the company, because in the production planning process the company will determine how many products they have to produce, on time for completion, the capacity of available resources ranging from workers, raw materials, to machine capacity so that market demand can be met appropriatel garety. In the production process, production planning and control will be carried out so that optimal production costs are obtained. To achieve company goals as well as production control, the aim is to utilize limited production resources appropriately, especially in an effort to meet consumer demand and create profits for the company [1].

According to [2]The success of a company does not only depend on the amount of income it earns, but is also built on efficient, effective and good processes to survive in increasingly tight business competition. In the face of intensive competition in the modern business world, companies need to increase their productivity by managing superior production systems, optimizing the use of resources, and improving the quality of their products. Continuously developing technology and rapid market dynamics in the manufacturing industry require that companies can meet consumer expectations with high quality products that comply with established standards. Factory operations can run efficiently and effectively if quality control is implemented well to reduce the number of defective products and ensure the achievement of the desired quality standards. Despite a surge in demand from consumers, competition in the market is not getting any easier. This is proven by the emergence of new factories with large production capacities. Therefore, factories must be able to produce high quality products in order to compete with similar companies in this increasingly fierce market.

Quality is a component that can become the company's basic model so that it can survive as a superior company and be able to compete in any era. The quality management system cannot be separated from the implementation of quality within the company. Product quality can be measured from its dimensions. (According to David A. Garvin in 1987), there were 8 (eight) dimensions of product quality including: Performance, Features, Reliability, Conformity, Durability, Ease of Service, Aesthetics and Perceived Quality [3].

Currently, competition in trade, both in industry and manufacturing, is very tight. Every company has quality standards that must be maintained to keep their products in demand by consumers. Apart from that, these companies must also continue to maintain and improve the quality of their products in order to compete with other competitors in the market.

According to [4]the crucial factor in producing quality products is part of the production process itself. Effective quality control is very important in efforts to improve product quality and reduce the number of defects. The causes of product defects vary, including human factors, machines, raw materials, work methods, and work environment. Therefore, to prevent product defects, increase customer satisfaction, and build trust, companies need to implement methods that support quality improvement. This will help the company to remain competitive in the highly competitive global market.

According to Feingenbaum in [5] quality control is a series of techniques and actions planned to achieve, maintain and improve the quality of products and services, so that they comply with predetermined standards and meet consumer satisfaction. The main objective of quality control is to ensure that the quality of the products or services produced is in accordance with established standards.Quality control measures must be carried out continuously and continuously. The quality control process can be carried out through the application of the PDCA (Plan – Do – Check – Act) cycle introduced by Dr. W. Edwards Deming, a well-known quality expert from the United States [6].

Based on observations made by researchers, there are defects that still occur in shoe production. After identification, shoes are classified into three grades: A-Grade are shoes that are ready to be sold with good quality, B-Grade have defects or damage to the material, and C-Grade are shoes that are not ready to be sold because they have significant defects or not. meet the standards. The presence of defective products has a direct impact on reducing company performance and causing losses, especially in the distribution process. To overcome this problem and reduce the level of product defects, this research proposes implementing a quality control method using *Statistical Quality Control* (SQC).

P-Chart is a tool that can be used for statistical process control. P- Chart was chosen to be used, because quality control is attribute in nature. The P-Chart shows changes in data over time, with the inclusion of maximum and minimum limits which are the boundaries of the control area. P-Chart has the advantage that it can help control packaging defects and can provide information about when and where companies need to make quality improvements [7]

The control method uses *Statistical Quality Control* (SQC) which is a system designed to maintain consistent quality standards for production results. By implementing quality control and using statistical methods, it is hoped that it can have a significant impact on the final quality of the product so that it meets company standards and is cost efficient. Production quality must be controlled and improved continuously. If the production method is not optimal, the company needs to carry out supervision or quality control which aims to ensure that the products produced comply with the established standards. P-Chart, or Proportion Chart, is a tool used in Statistical Quality Control (SQC) to monitor the proportion of defective units in a sample from the production process. P-Charts are very useful in situations where a product or service can be classified as defective or non-defective

P-Chart is usually used to describe the proportion of production that does not meet requirements. If you use data that varies or is different in size, then the upper control limit and lower control limit of the P-chart will not be flat. P-charts can also be used for data that has the same or not sample subgroup sizes. Calculations carried out in making the P control map include: calculation of defect proportion values, calculation of the Upper Control Limit (UCL) and Lower Control Limit (LCL). UCL and LCL are used to make it easier to monitor the quality produced, and to determine the quality produced in accordance with standards [8]

In this research, researchers used P-Chart Analysis to monitor the proportion or percentage of damaged products from finished production. The main goal is to detect errors before the product reaches the sales stage. Based on the problems above, the author is interested in conducting research on *Quality Control* with the title " ***Statistical Quality Control (SQC)*** **Method Analysis of Shoe Product Quality Control".**

METHOD

Data Source

This research uses secondary data obtained from PT – X, an industrial company that produces shoes in December 2023.

Research Variables

The variables used in this research are the results of rejected shoe production at Company X in the period December 2023. In processing the data obtained, PT. X identifies three types of damage to shoes, which are divided into three categories:

a. A-Grade Shoes: Shoes that pass QC checks (release).
b. B-Grade Shoes: Shoes that are defective in material, such as:
- Shoe production does not match the sample.
- Damage to materials or defects due to processing or exposure to machinery (material damage).
- Open bonding on the upper (the part of the shoe that covers the entire upper foot) and outsole (bottom of the shoe), as well as uneven application of upper and outsole glue (Open bonding).
- Too much glue on the upper part that exceeds 3mm (Over cement).
- Slope on shoes (Overlay).
- There is metal material in the shoes (Metal material).
- Defects in materials that can be repaired. If it cannot be repaired, the shoes will be sold at half price to the supplier itself.

c. C-Grad e Shoes: Shoes that do not meet the SOP, have fatal damage, and must be destroyed. PT. The Shoe making model at PT. X must be in accordance with the PO that has been determined or planned according to the PO.

Flow Diagram

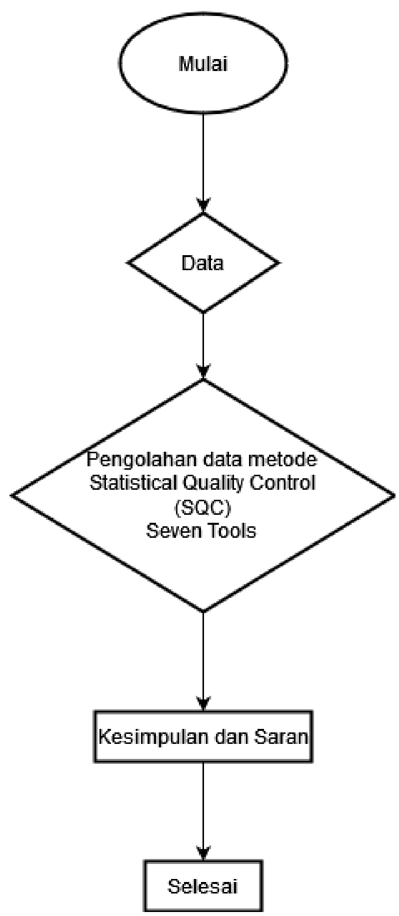

Figure 1. Research Flow Diagram

The flow diagram describes the data processing process using the Statistical Quality Control (SQC) method with Seven Tools. The process begins with collecting relevant data, followed by processing the data using seven main SQC tools: Check Sheet, Control Chart, Histogram, Pareto Chart, Cause-and-Effect Diagram, Scatter Diagram, and Flow Chart. After data processing is complete, the results of the analysis are used to draw conclusions and provide suggestions for improvement. The final stage of this process is completion, where all conclusions and recommendations are concluded and corrective actions are proposed to improve the quality of the process or product [9].

RESULT AND DISCUSSION

Based on the research above, there are several steps in carrying out quality control using the *Statistical Quality Control method*. The first step is to create and fill out a check sheet which is useful for simplifying the data collection process and for identifying problems that occur based on the type or cause.

Check Sheet

Table 1. Check Sheet

No	Date	Production	Type of Damage					Number of defects
			Open Boanding	Over Semen	Overlay	Damage Material	Metal Material	
1	1 Desember 2023	1200	25	37	25	7	5	99
2	4 Desember 2023	1190	40	35	30	12	7	124
3	5 Desember 2023	1130	34	35	32	8	12	121
4	6 Desember 2023	1105	37	47	20	10	6	120
5	7 Desember 2023	980	46	20	18	4	5	93
6	8 Desember 2023	1100	33	48	25	13	3	122
7	11 Desember 2023	950	36	40	28	8	10	122
8	12 Desember 2023	1080	34	30	20	5	8	97
9	13Desember 2023	1025	22	35	24	3	5	89
10	14 Desember 2023	1115	41	50	32	2	16	141
11	15 Desember 2023	970	27	42	28	13	2	112
12	18 Desember 2023	950	37	34	35	5	7	118
13	19 Desember 2023	1150	29	37	31	7	5	109
14	20 Desember 2023	1105	24	29	20	6	7	86
15	21 Desember 2023	1030	33	61	43	4	9	150
16	22 Desember 2023	940	13	40	30	6	11	100
17	26 Desember 2023	1200	19	45	32	8	8	112
18	27 Desember 2023	1215	27	46	25	3	4	105
19	28 Desember 2023	1130	45	59	31	8	6	149
20	29 Desember 2023	1160	33	52	22	7	8	122
	Total	21725	635	822	551	139	144	2291

From the *check sheet table* aboved there are 5 types of defects or types of damage, consisting of 635 *Open Bonding units,* 822 *Over Cement units,* 551 *Overlay units,* 139 *Damage Materials, and* 144 *Metal Materials.*

Histogram

After the check sheet is created, the next step is to create a histogram. Histograms are useful for making it easier to see the types of damage that occur most frequently.

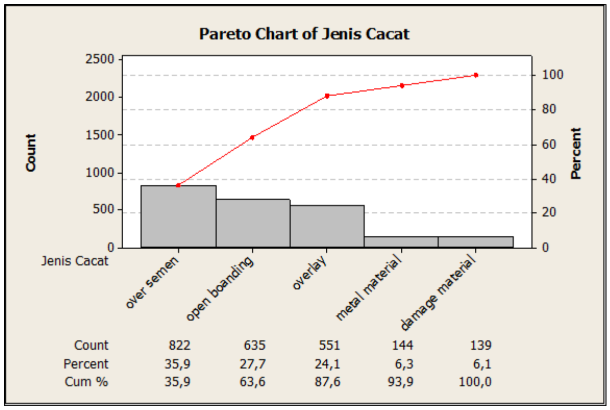

Figure 2. Pareto Diagram for Types of Shoe Product Damage

Based on the Pareto diagram above, it can be seen that the type of damage that occurs most frequently is Over Cement with a percentage reaching 35.9%. The second most frequently occurring damage is Open Bonding with a percentage of 27.7%. Furthermore, damage to Overlay reached 24.1%, damage to Metal Material was 6.3%, and damage to Damage Material was 6.1%. From this diagram, it can be concluded that Over Cement defects are the highest, so it is a major concern for the shoe industry to be careful about this type of defect.

Control Chart

A control chart is a graphic method used to evaluate whether a process or product is within statistical quality control limits or not. The goal is to monitor and control process variability so as to identify problems and produce necessary quality improvements [10]. The steps in creating a P control chart:

a. Calculating Damage Percentage

$$P = \frac{np}{n} \quad (1)$$

$$P = \frac{2290}{21725}$$

$$= 0.1054$$

b. Calculating the center line *(CL)*

$$CL = \bar{P} = \frac{\sum np}{\sum n} \quad (2)$$

$$= \frac{2290}{21725}$$

$$= 0.1054$$

c. Upper *control limit (UCL)*

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

$$= 0.1054 + 3\sqrt{\frac{0,1054\ \ (1-0,1054)}{21725}}$$

$$= 0.1054 + 0.01$$

$$= 0,1117$$

d. Calculating the lower control limit *Lower Control Limit (LCL)*

$$LCL = \bar{P} - 3\sqrt{\frac{\bar{p}\,(1-\bar{p}}{n}} \quad (4)$$

$$= 0.1054 - 3\sqrt{\frac{0{,}1054\;(1-0{,}1054)}{21725}}$$

$$= 0.1054 - 0.01$$

$$= 0.0992$$

Based on the calculations above, the complete P Control Map calculation results can be made for December 2023 as can be seen in the following table:

Table 2. Control Limits P with the help of Microsoft Excel

proporsi	CL	UCL	LCL
0,08	0,1054	0,1117	0,0992
0,10	0,1054	0,1117	0,0992
0,11	0,1054	0,1117	0,0992
0,11	0,1054	0,1117	0,0992
0,09	0,1054	0,1117	0,0992
0,11	0,1054	0,1117	0,0992
0,13	0,1054	0,1117	0,0992
0,09	0,1054	0,1117	0,0992
0,09	0,1054	0,1117	0,0992
0,13	0,1054	0,1117	0,0992
0,12	0,1054	0,1117	0,0992
0,12	0,1054	0,1117	0,0992
0,09	0,1054	0,1117	0,0992
0,08	0,1054	0,1117	0,0992
0,15	0,1054	0,1117	0,0992
0,11	0,1054	0,1117	0,0992
0,09	0,1054	0,1117	0,0992
0,09	0,1054	0,1117	0,0992
0,13	0,1054	0,1117	0,0992
0,11	0,1054	0,1117	0,0992

After calculating CL, UCL, and LCL in the table above, a P control chart (P-Chart) can be created using the help of Minitab which can be seen in the following image:

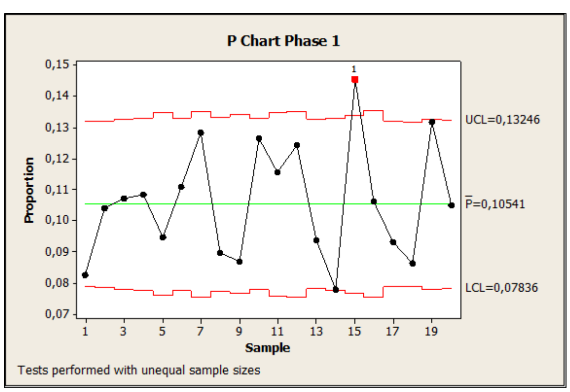

Figure 3. P Control Chart Graph (P – Chart)

From the graphic image above, it can be seen that at point 15, namely on December 21 2023, there is data that is outside the control limits. From the results of observations, the cause of the data leaving the control limits was due to a lack of accuracy on the part of employees and differences in the materials received, which were different from usual. Once the cause is known, the 15th data is deleted, and the updated control chart can be seen in the following image:

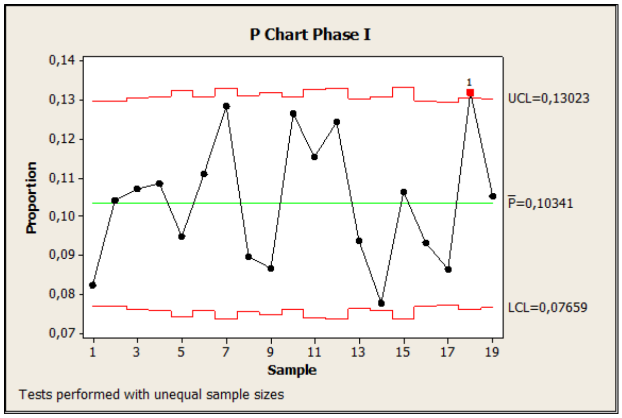

Figure 4. P Control Chart (P – Chart) After the 15th Data Deletion

From the graphic image above, it seems that there is still one data that exceeds the control limits. This happened at the 18th point on December 28, 2023. From the observations, it was discovered that the cause of the data leaving the control limits was because the operator was carrying out work in a hurry because he was tired and wanted to rest quickly. Therefore, the data at the 18th point is deleted, and the updated control chart can be seen in the following figure:

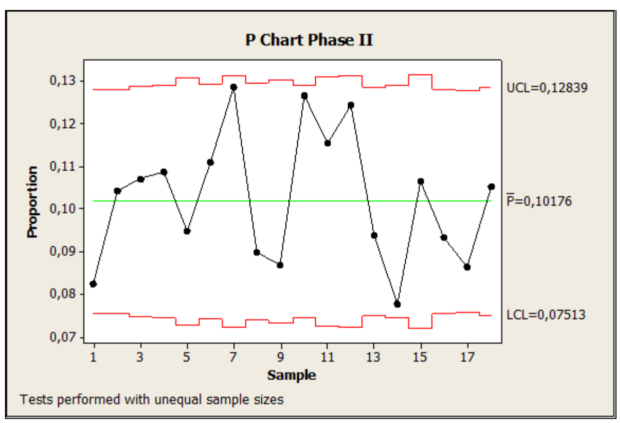

Figure 5. P Control Chart (P – Chart) After the 18th Data Deletion

From the graphic image above, it can be seen that there are no lines on the graph that exceed the control limits or *are out of control*, which means that all samples are within the accepted area. This shows that the sample has normal behavior or a stable condition.

Cause and Effect Diagram

The use of cause-and-effect diagrams is to help solve the problems faced by linking the causes and the factors that influence them. In a company, of course, there are applicable SOPs

(Standard Operational Procedures) , which will determine whether the implementation has been effective or not. This will be proven by a cause and effect diagram caused by several types of failure or defective products including those caused by *Over Lay* (slope), *Damage Material, Metal Material* (metal material), *Over Cementing* (lots of glue), and *Open Boanding* (bonding). open).

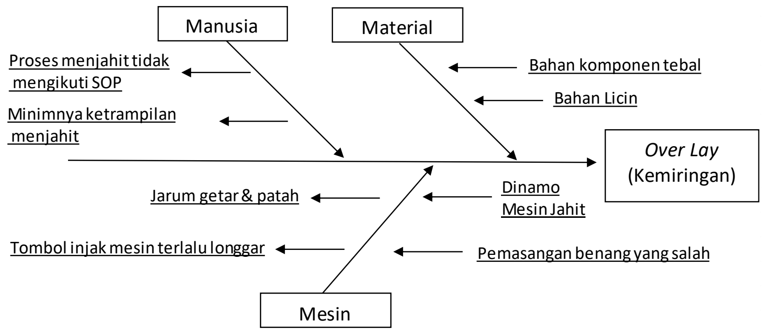

Figure 6. Fishbone (cause and effect) Diagram of Shoe Production Based on Over Lay

It can be seen in Figure 6 Fishbone Diagram for Shoe Production that there are three factors that cause defective products, namely human factors, material factors and machine factors.

1. Human Factors
   It was found that labor factors that cause defective products in shoe production include sewing processes that do not follow SOPs, lack of sewing skills, operators being in a hurry and not being careful.
2. Material Factors
   Problems were found with the component materials that arrived, because the materials that arrived were not as usual, such as thick materials and slippery materials, making it difficult for operators to sew.
3. Machine Factor
   Problems were found in machine maintenance that were not checked regularly and on a schedule, resulting in decreased performance of the machine, such as sewing machine dynamos, needles vibrating and breaking, machine push buttons that were too loose, and incorrect thread installation.

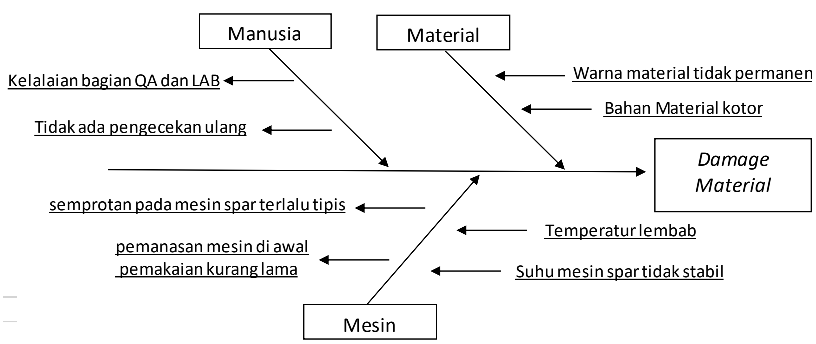

Figure 7. Fishbone (cause and effect) Diagram of Shoe Production Based on Damage Material

It can be seen in Figure 7 Shoe Production Fishbone Diagram that there are three factors that cause defective products, namely human factors, material factors and machine factors.

1. Human Factors
   It was found that there was negligence on the part of QA and LAB and there was no re-checking of the goods used.
2. Material Factors
   Problems were found with dirty materials and non-permanent material colors
3. Machine Factor
   Problems were found in engine maintenance that were not checked, such as damp temperatures, unstable spar engine temperatures, engine heating at the start of use that was not long enough, and the spray on the spar engine was too thin.

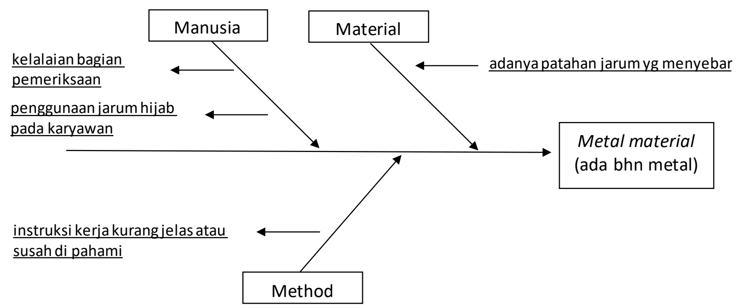

Figure 8. Fishbone (cause and effect) Diagram of Shoe Production Based on Metal Material

It can be seen in Figure 8 Shoe Production Fishbone Diagram that there are three factors that cause defective products, namely human factors, material factors and method factors.

1. Human Factors
   Factors found were negligence on the part of the inspection, and the use of hijab needles on employees.
2. Material Factors
   The problem was discovered because there was a widespread needle fracture.
3. Method Factor
   Problems found, namely work instructions that are unclear or difficult to understand.

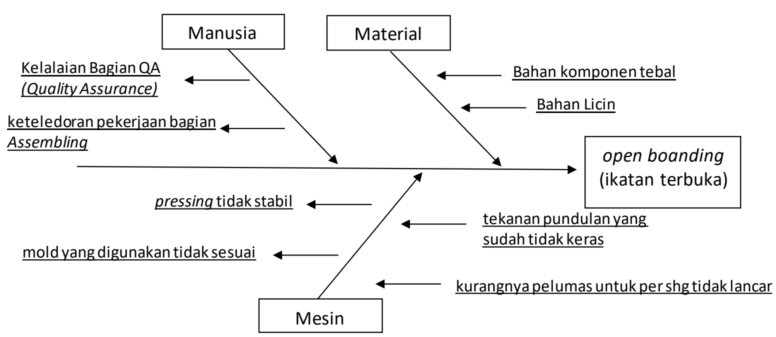

Figure 9. Fishbone (cause and effect) Diagram of Shoe Production Based on Open Boanding

It can be seen in Figure 9 Shoe Production Fishbone Diagram that there are three factors that cause defective products, namely human factors, material factors and machine factors.

1. Human Factors
   Factors found were negligence in the QA (Quality Assurance) department, and negligence in the work of the Assembling department.

2. Material Factors
   Problems were found with the materials, namely thick component materials and slippery materials.
3. Machine Factor
   The problems found were that the pressing machine was unstable, the mold used was not suitable, there was a lack of lubricant for the spring so it did not run smoothly, and the pressure on the bending was no longer firm.

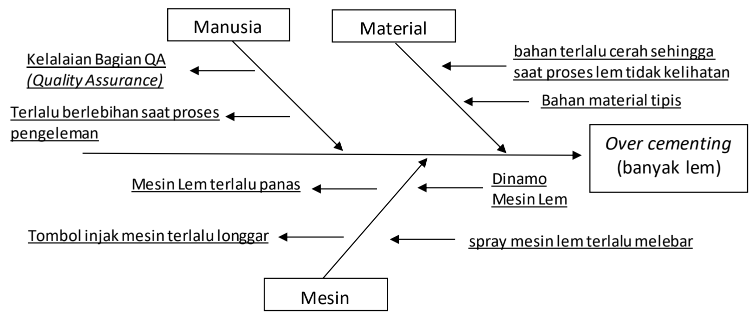

Figure 10. Fishbone (cause and effect) Diagram of Shoe Production Based on Over Cementing

It can be seen in Figure 10 Shoe Production Fishbone Diagram that there are three factors that cause defective products, namely human factors, material factors and machine factors.

1. Human Factors
   Factors found were negligence by the QA *(Quality Assurance) department* , and operators who were too excessive during the gluing process.
2. Material Factors
   Problems were found with the material, namely the material was too bright so that during the gluing process it exceeded the limit, and the material was thin.
3. Machine Factor
   The problems found were that the glue machine was too hot, the engine push button was too loose, the glue machine dynamo was not double checked, and the glue machine spray was too wide, causing the glue to spread everywhere.

CONCLUSION

Based on the data that has been analyzed along with the discussion described in the previous chapter regarding the results of the shoe production process at PT – X, the following conclusions can be drawn:

1. Based on the Pareto diagram, it can be concluded that the type of damage that often occurs in the shoe production process is *over cement* with a percentage reaching 35.9%, then there is *open boanding* reaching 27.7%, then there is *overlay* with a total damage reaching 24.1%. Next, *metal material* damage was 6.3%, and *material damage* was 6.1%.
2. From the P-Chart analysis it can be concluded that there are points that are outside the control limits (Out of Control), once the cause is known then the data that causes the out of control is recorded. Remove it and process it again using Minitab. Once it is known that there are no lines on the graph that exceed the control limits or are out of control , this means that all samples are in the accepted area. This shows that the sample has normal behavior or a stable condition.

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