IMPROVEMENT BONDING QUALITY OF SHOE USING QUALITY CONTROL CIRCLE

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Abstract — Shoe industry development in the era of globalization is currently overgrowing. Therefore, every company should be able to compete strictly with other companies that produce the same products. Quality maintenance is having to be done by the company to survive in business competition. PT. ABC is a manufacturer of sports shoes. The company has a problem with bonding shoes not achieved company standard in the year 2017. This paper is focused on the improvement of bonding shoe quality by using a method of Quality Control Circle which applying quality control tools are like check sheet, Pareto diagram, fishbone diagram, and 5W + 1 H. Based on the research results obtained percentage improvements of quality bonding test of 21.15%. Cement stripping on the midsole is the most significant number of the bonding test failure in Laboratory that is as much as 26.33% or 218 prs from the total collapse of the overall bonding shoes. Based on the background, the purpose of this research is to find out the root causes of the failure of bonding test shoes. The limitations of this research are only improving processes in the department, which makes the bonding shoe quality does not achieve the company standard. After doing the analysis using the quality control tools and making the improvement process in the whole areas that the percentage of the bonding test cement stripping on midsole could be increased to 5.18%. Analysis of the results obtained by applying the method of Quality Control Circle is the improvement of the quality of the bonding shoe. So, the trust customers against the company may be obtained that would eventually increase the number of orders to the company.

Keywords: Quality Control Circle; Bonding shoes; Stock fitting process; Quality control tools

INTRODUCTION

PT. ABC is a company that produced sports shoes (Triana & Beatrix, 2019). The company has a problem of quality bonding shoes which did not meet the company target in the year 2017. The bonding test result percentage of finished shoes in the year 2017 is 78.6%. The objective of the company is 98%. Currently, process monitoring of the quality control system’s only focused on some department, not for the whole department. The company used the PDCA (Plan, Do, Check, Action) cycle method to solve the bonding problem (Mukherjee, 2019).

Quality control can be done using the concept of the PDCA cycle, which was introduced by Dr. W. Edwards Deming, an expert in quality control. Therefore, it is known as the cycle of Deming (Deming, 1982). PDCA cycle is a process for continuous improvement, has no beginning or end (Agrawal, 2019; La Verde et al., 2019; Herjanto, 2017).

The quality of the bonding is determined by the results of the work of the entire department. The process is starting from the design phase up to the assembly process. Therefore, researchers applying the quality control circle method for solving bonding problems.

Some references of journals that discussed for improving the quality product using the PDCA cycle. Sari et al. (2018) with research using methods a cementing process stock for fitting bottom shoes running utilizing the technique of PDCA in each process and then analyze the test results with adapting the bonding quality control tools. Another method that can be used to identify the problem, eliminate or reduce potential failure, or reject a product is FMEA (Kholil & Prasetyo, 2017). Therefore authors choose methods of QCC (Quality Control Circle) (Nemer & Vieria, 2018; Xia et al., 2016) to improve the quality of bonding shoes desired by the company.

This research aims to find out the root cause of the bonding shoe failure and how to...
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Monitor the quality of the bonding shoes in daily operation.

**MATERIAL AND METHOD**

**Material**

According to Wignjosoebroto (2003) Quality Control Circle is a small group of employees, sometimes lead by a supervisor who will voluntarily find ways to improve the quality and reduce production costs in the production system. According to Ishikawa (1983), Quality Control Circle is a small working group that voluntarily works to carry out quality control.

The positive thing that will also grow along with the development of QCC activities is the creation of a very supportive work atmosphere and encourages employees to explore their creativity and potential continually. It is given that the purpose of this QCC is to optimize assets owned by companies/organizations, especially skills development and the workers themselves better and respect human values and create a conducive workplace, to improve quality in the broad sense and growth of the company. Besides, the application of the QCC is also a tangible form of involvement of all parties. In this case, those who are in lower management, the improvement and development of companies/organizations. The goals to be achieved through QCC activities include: reducing work mistakes and improving quality, improving better cooperation, and increasing employee awareness in carrying out their duties. Besides, training employee skills in solving problems they face, instilling awareness about the importance of prevention from the beginning, developing a more harmonious and communicative relationship between the manager and his employees, encouraging personal development and leadership. This goal was caused by ignorance and lack of management knowledge identifying problems, how to find out the root cause, and how to improve the bonding quality problems that occur.

The manufacturer's perspective and the perspective of customers will be met on the use of customer (fitness for customer use), so the suitability between customers with customers that can result in a mutually agreed standard and can meet needs and expectations of both sides (Maysaroh & Husein, 2015).

Development of quality control the inspector's activities are enhanced by various statistical methods (Riyanto, 2015).

1. Quality Control Operator Stage. This stage is when the operator is responsible and does all the tasks of determining the quality of a product as a whole.
2. Foreman Quality Control Stage. This stage is when the foreman holds all the tasks of quality control.
3. Inspection Quality Control Stage. This stage is when doing all the tasks of quality control.
4. Statistical Quality Control. Stage This stage is when various statistical methods enhance tasks that are usually centered on the inspector's activities.
5. Total Quality Control stage. This stage is used in the production floor, all team from superiors until subordinates are responsible for quality control tasks there is.

**Method**

The methodology in this study is shown in Fig. 1. In Fig. 1, the quality control process that is using check sheet, Pareto diagrams, fishbone diagrams, and 5W+1H.

![Flowchart Methodology Research](image)

In this study, the method used is the Quality Control Circle. Because the Quality Control Circle method focuses more on controlling product quality in making improvements with the PDCA and Seven tools cycles, also, this method was chosen because it has structured and measurable steps in solving problems, so that based on existing data and facts, improvements can be made. Because of the implementation of Quality
Control Circle is needed to know the cause of a problem and get a solution to solve the problem. The background of the existing problems, an observation of the current product quality control is done to minimize bond test failure at PT ABC. The objectives to be achieved in this study to determine the causes of dominant and non-dominant defects in the products in PT ABC and determine the improvements that must be made to minimize the number of consumer complaints with the Quality Control Circle (QCC) method.

The data used in this study are laboratory test data of PT. ABC relating to product quality on bonding shoe test. The test is done where field observations are carried out to observe firsthand how the shoe production process on stock fitting and assembling by ensuring the bonding process of the bottom of the finished shoes (outsole and upper) part of the shoe running in accordance with Bonding Flowchart process that has been approved by the customer/buyer.

The method used in sampling (sampling) shoes to be tested in the Laboratory is 0.004% of the monthly production following customer/buyer standards. The observations at the Laboratory of PT. ABC can be taken secondary data in the form of the number of bond failures on the testing of shoes every month. So, it is hoped that solutions can be found to minimize bond failure in the shoe product.

After the data has been collected and has been identified, then the data is processed according to the purpose of solving the problem. The data processing steps include:
1. Calculating the frequency of bond test failure in the Laboratory for improving the production process.
2. Make an improvement plan using the 5 W + 1 H method which will later be made a matrix containing the purpose of improvement, how to improve, time of implementation, area of development and person in charge of each improvement activity.
3. They are monitoring the repair process, whether the improvement is by the plan or not. The aim is to collect, and document data or records regarding implementation, which include conditions before development and after repairs are carried out. This documentation will be used as data or basis in the evaluation phase of the results of improvements. The implementation of this improvement will later be found a solution to the existing problems.
4. Evaluate the results of improvements made to determine whether or not the improvements have been implemented.

Next analyzing is bond test system in the Laboratory. It was starting from picking up the sample from the production floor, doing the bonding test, evaluation bond test result and released the bond test result by Laboratory Manager. Then, Lab Manager submitted the bond test report to Quality Director and Production Management, as seen in Fig. 2.

![Flowchart Laboratory Bonding Test](image-url)

**RESULTS AND DISCUSSION**

**Production Process**

The production process of PT. ABC is divided into two departments, namely: Stock fitting Department is the part that works on attaching the rubber sole to the midsole.

Assembling Department is the part that works on attaching the outsole to the upper.

To ensure the production processes of the installation of the components mentioned above will run correctly and consistently so that it will produce quality shoes by company standards, then PT. ABC provides the bonding process flowchart before run mass production.

The Bonding Process Flowchart for the stock fitting department and assembling department, as seen in Fig. 3, and Fig. 4.
The following is the new working system after formed team Quality Control Circle (QCC) to find out the root cause of the problem in bonding test that does not meet specifications of the customer. Team Quality Control Circle make a bonding test using the tools of quality control, can be seen in Fig. 5.

**Establishment of the QCC team**

The QCC team is essential in supporting the smooth running of research, especially to find a problem and a solution. The formation of this team consists of 5 to 10 people and in one job. There are several ways to allow greater employee participation, but the more accepted and practiced one is the creation and utilization of a Quality Control Circle (Urubio, 2016).
Critical To Quality (CTQ) Determination

Critical To Quality Determination (CTQ) is performed for attribute characteristics. This is performed because consumers (internal consumers) often provide complaints against various types of bond failure. Shoes that qualify for internal consumers (stock fitting and assembling departments). In addition to multiple types of bond failures that function as CTQ (famous for quality), that is by choosing various types of bond failures that are most dominant. Because of the nature of bond failure that significantly affects the results and quality of the product.

The types of bond failure after the laboratory test determined by the customer/buyer are as follows:

- Material failure. Indicates material failure in laboratory tests that do not meet bond specifications.
- Cement film splitting between the upper (upper part of the shoe) and outsole (bottom part of the shoe). Indicates that there is glue on the upper and outsole.
- Cement film splitting between midsole and rubber sole. Indicates that there is glue on the midsole and rubber sole.
- Cement stripping of the midsole component indicates that there is no glue on the midsole.
- Cement stripping from sole rubber components indicates that there is no glue on the outsole.
- Cement stripping from the upper component indicates there is no glue on the top.

The percentage of the bonding test result from January-December 2017 is listed in Table 1:

Table 1. Percentage of Bonding Test results 2017

| Month   | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sept | Oct  | Nov  | Dec  | Average |
|---------|------|------|------|------|------|------|------|------|------|------|------|------|---------|
| %       | 65.3 | 62.3 | 73.0 | 78.6 | 72.3 | 73.7 | 76.7 | 79.7 | 83.4 | 92.5 | 92.5 | 94.0 | 78.7    |
| Standard| 98.0 | 98.0 | 98.0 | 98.0 | 98.0 | 98.0 | 98.0 | 98.0 | 98.0 | 98.0 | 98.0 | 98.0 | 98.0    |

The data in Table 1 shows the bonding test results in 2017 are below the company standard. For this reason, the researchers want to make improvements by using the Quality Control Circle method. To make it easier for repairing, an analysis of the type and amount of bond failure is highest in 2017. The following are data types and bond failure amounts in 2017 as analysis data for corrective actions.

From the data in Table 2, a Pareto diagram is made to determine the type of bond test failure on the most significant percentage of shoe bonding. Table 3 shows a calculation of bond failure in 2017.

Table 2. Type and Amount of Bond Failure in 2017

| No  | Type of Bond Failure                          | No of Bond Failure (prs) | %    |
|-----|-----------------------------------------------|--------------------------|------|
| 1.  | Cement stripping from the midsole.             | 35 21 34 25 18 7 24 21 25 31 25 15 | 26.3 |
| 2.  | Cement splitting between upper & midsole       | 32 23 38 16 23 5 20 14 30 32 22 19 | 52.0 |
| 3.  | Cement stripping from upper                    | 31 18 29 18 27 6 17 17 21 35 26 11 | 76.0 |
| 4.  | Cement stripping from upper                    | 29 23 19 15 24 4 25 15 19 32 0 9 | 97.8 |
| 5.  | Cement stripping from the outsole              | 2 1 4 0 3 2 1 3 1 4 2 0 | 100  |
| 6.  | Material failure                               | 129 86 124 74 95 24 87 70 96 134 75 54 |     |
|     | Total                                          |                           |      |

Table 3. Bond Failure Types 2017

| No  | Type of failure                          | No of bond failure (prs) | %    | Cumulative (%) |
|-----|------------------------------------------|--------------------------|------|-----------------|
| 1.  | Cement stripping from the midsole.        | 281                      | 26.3 | 26.3            |
| 2.  | Cement splitting between the upper & midsole | 274                 | 25.7 | 52.1            |
| 3.  | Cement stripping from the upper           | 256                      | 24.0 | 76.0            |
| 4.  | Cement stripping from the outsole         | 233                      | 21.8 | 97.8            |
| 5.  | Material failure                          | 23                       | 2.2  | 100             |
From the results of the calculation, the Pareto rule 80-20 be applied in deciding which part on the results of the test give the bonding influence significantly to bond failures. The results of diagram Pareto in Fig. 6 shows the type of bond failure is cement stripping from the midsole. The analysis will then be carried out using a fishbone diagram to find out the root cause of the bond failure cement stripping from the midsole.

Fig. 7 shows a fishbone diagram to find the potential cause of bond failure cement stripping from a midsole.

Fishbone diagram above is part of the seven tools that are used to analyze the causes of the main problems that occur at PT. A B C. In this study, it was found that bond failure cement stripping from midsole that occurs in the stock fitting production process. From the base of this problem will be analyzed the causes of the occurrence of this problem so that the main root problems are obtained which are then considered whether the corrective steps for this matter.

Following the results of the analysis using the Pareto diagram, it is known that the most significant defect is dominated by cement stripping of the midsole.

The following is an explanation of 5W + 1H for the planned failure of bond failure cement stripping from the midsole:

What: Make improvements to man, machine, material, method, and environment.
When: Repair was done in January 2018
Who: Team QCC.
Where: The problem occurs in the stock fitting production process of PT. ABC
Why: For the issue of bond failure cement stripping in the midsole to be improved immediately on some potential causes of the problems (man, machine, material, method, and environment)
How: Make improvements to each object of the problem.

Table 4 lists an improvement planned of bond failure cement stripping from midsole in the stock fitting department.
Table 4. Improvement Plan uses 5W + 1H in the Stock fitting Section

| No. | Possible Causes | What | Why | Where | When | Who | How |
|-----|----------------|------|-----|-------|------|-----|-----|
| 1.  | Machine        | Setting Speed machine | For making UV joule m/c has fit the standard | Stock fitting | Jan 2017 | QCC | Check UV joule machine on regular basis |
|     | Temp machine chamber is not fit the standard | Repair machine | For making temperature chamber machine fit the standard | Stock fitting | Jan 2017 | QCC | Check machine condition daily |
|     | Men            | The operator does not follow the SOP | The operator should be followed SOP | Stock fitting | Jan 2017 | QCC | Training and monitoring operator |
| 2.  | Operator less training | Provide a training plan | The operator should be trained regularly | Stock fitting | Jan 2017 | QCC | Training operator on a regular basis |
|     | Method         | Update SOP | The process should be followed by the standard | Stock fitting | Jan 2017 | QCC | Check SOP in all areas |
|     | SOP not available | Provide SOP | The process should be followed by the standard | Stock fitting | Jan 2017 | QCC | Check SOP in all areas |
| 3.  | Material       | Check the quality of material before using | Ensuring quality of the material should be followed the spec | Stock fitting | Jan 2017 | QCC | Doing a physical test of material/raw chemical in Lab |
|     | Quality adhesive out of spec | Check the quality of adhesive before using | Ensuring quality of chemical should be followed the spec | Stock fitting | Jan 2017 | QCC | Doing a bond test in Lab by daily basis |
| 4.  | Environment    | Repair room temp | Ensuring room temp follow the standard | Stock fitting | Jan 2017 | QCC | Checking room temp on a daily basis |

The improvement of bond failure cement stripping from the midsole using 5W + 1H in some dominant causes as in the table above will facilitate the monitoring process.

Furthermore, the study continued with evaluating the results of improvements by analyzing the percentage data of bond failure cement stripping from midsole during 2018.

The percentage of bond failure cement stripping from midsole in the year 2017, as shown in Table 5.

The data in Table 5 shows that the number of samples tested and the number of bond failure cement stripping from the midsole that has been carried out at the Laboratory of PT. ABC in 2017 is an average of 26.33% can be seen in Table 6.
Table 5. Percentage of bond failure cement stripping from midsole 2017

| Month | No of sample (prs) | No of failure (prs) | %  |
|-------|-------------------|---------------------|----|
| Jan   | 129               | 35                  | 27.13 |
| Feb   | 86                | 21                  | 24.41 |
| Mar   | 124               | 34                  | 27.42 |
| Apr   | 74                | 25                  | 33.78 |
| May   | 95                | 18                  | 18.95 |
| Jun   | 24                | 7                   | 29.17 |
| Jul   | 87                | 24                  | 27.59 |
| Aug   | 70                | 21                  | 30.00 |
| Sept  | 96                | 25                  | 26.04 |
| Oct   | 134               | 31                  | 23.13 |
| Nov   | 94                | 25                  | 26.60 |
| Dec   | 54                | 15                  | 27.78 |

Table 6. Percentage of bond failure cement stripping from midsole before improvement 2017

| Before improvement |
|--------------------|
| No of samples (prs) | No of Bond failure (prs) | %  |
| 1067               | 281                | 26.33 |

After doing improvement using the Quality Control Circle method, the data is then collected and evaluated. As can be seen below, the percentage of bond failure cement stripping from the midsole has decreased only by an average of 5.18% in 2018.

Table 7. Percentage of bond failure cement stripping on midsole after improvement 2018

| After improvement |
|--------------------|
| No of samples (prs) | No of Bond failure (prs) | %  |
| 1253               | 65                  | 5.18 |

The results of the data processing as seen in Table 6 and Table 7 above, bond failure cement stripping from the midsole before improvement in the year 2017 and bond failure cement stripping on the midsole after improvement in the year 2018. It can be seen that there is a decrease in the percentage of bond failure cement stripping from the midsole become 21.15%.

CONCLUSION

Based on the processing and data analysis of this study, the conclusions of the researchers as follows. The essential type of bond failure is cement stripping from the midsole. Process improvement of the bond failure cements stripping from the midsole using the 5W + 1H. The results of cement stripping from midsoles are increased to 21.15% in 2018. The method of Quality Control Circle is very useful to apply because all teams could be directly involved in the whole processes for improving the quality of bonding shoes.

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