Quality Control on Bucket Production Process Using Quality Tools Method (Case Study: A Medium Sized Company)

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Abstract. This study aims to identify and solve the root causes of the defective products in the injection production line in a company that produces bucket and pipe-related products made from plastic ores. In order to maintain the quality of their products, this company has to figure out what to do in order to pay attention more in their actions to minimize the defects occurred from the production process. Good quality products are also very important to maintain the good relation with their customers. The samples for this research are taken directly from the field and analyzed using the quality tools method which are control chart and pareto diagram, also an addition method of the five-whys analysis to figure out the root causes. Based on the research results, the defective products that occurred in the production process are still in control but still needs to be improved right away. Another result also shows that the root causes are categorized to four groups varies from man, machine, method, and material. Therefore, there are two ways to overcome this problem: preventive and repressive action. The results of this study can be used as a reference in the future for a quality control applied in various companies.

Keywords: quality, control, quality tools, defects, root causes.

1. Introduction

This study aims to identify the defects occurred from the production process, analyze the root causes of defect problems in the injection production line and look for the best solutions for an improvement. Producing high-quality products is important for any manufacturing industry which should be given the priority in the process. Good quality products will bring the company to a level where it gives inevitable profits and customers’ satisfaction, that would definitely make customers continue purchasing the products if its quality is conformity to desired standards \cite{1},\cite{2}. Therefore, quality control is required. Quality control is used as a tool that makes the production process be more effective \cite{3}. The focus of this research is to identify every causes that happened to cause the defect problems in the production process using p-control chart and pareto diagram, not forget to mention that it is also needed to analyze the best way to overcome this problem by questioning using the five-whys analysis method. The mission is simply to supply customers the best service with trouble-free products. To achieve that goal, improvement is needed and will be implemented in the future to maintain the quality of their products.

2. Method and materials

2.1. Sample preparation
The defect sample was taken directly from 50 units in the field for 20 days and that makes it 1,000 in total. The observation is written in the check sheet to help the research become easier and can be tracked. This sample is used to identify every cause that happened to cause the defect problems in the production process. Therefore, quality of the products and productivity will be improved. Trouble-free products will eliminate the waste of scraps, which in turn will reduce the production costs and decrease the price in market. Reducing production costs will lead the company to remain competitive in an aggressive global market and increase their market share in the future [4],[5]. The flow on how quality improvements will help the company to reach the return on investment in the end is illustrated clearly in the Deming chain as seen below [6].

![Deming Chain](image)

**Figure 1.** Deming Chain [6]

### 2.2. Method
Control chart is implemented to see if the defective products are still between the upper and lower control limits; in other word, still in control or passing the boundaries. The formulas that are used in this calculation as follows [2],[7],[8]:

1. Center line (CL):
   \[
   CL = \bar{p} = \frac{\Sigma Di}{\Sigma n} \tag{1}
   \]

2. Upper control limit (UCL):
   \[
   UCL = \bar{p} + 3 \sqrt{\frac{\bar{p}(1-\bar{p})}{n}} \tag{2}
   \]

3. Lower control limit (LCL):
   \[
   LCL = \bar{p} - 3 \sqrt{\frac{\bar{p}(1-\bar{p})}{n}} \tag{3}
   \]

Meanwhile, pareto diagram consists of line and bar chart that shows the amount of defective products occur in certain length of time. Furthermore, the root causes of defect problems were identified using five-whys analysis [9],[10],[11]. In the end, improvements could be conducted refers to 20% vital causes so the 80% improvements could be done as a whole [12].

### 3. Results and discussion
3.1. Result using p-control chart

Quality control on defective products in this company is carried out by analyzing the check sheet based on an observation using the p-control chart (see Figure 2). The result of p-chart shows that this process is quite stable in the performance of 3 sigma. The data collection was obtained by taking samples of 50 units each day for 20 days and the result is shown in Table 1.

Table 1. Result of Defect Proportion

| No | Total Defects (pcs) | Proportion | \( LCL = \bar{p} - 3 \sqrt{\frac{p(1-p)}{n}} \) | CL | \( UCL = \bar{p} + 3 \sqrt{\frac{p(1-p)}{n}} \) |
|----|---------------------|------------|---------------------------------|----|---------------------------------|
| 1  | 7                   | 0.14       | 0                               | 0.143 | 0.292                  |
| 2  | 6                   | 0.12       | 0                               | 0.143 | 0.292                  |
| 3  | 10                  | 0.20       | 0                               | 0.143 | 0.292                  |
| 4  | 4                   | 0.08       | 0                               | 0.143 | 0.292                  |
| 5  | 9                   | 0.18       | 0                               | 0.143 | 0.292                  |
| 6  | 10                  | 0.20       | 0                               | 0.143 | 0.292                  |
| 7  | 11                  | 0.22       | 0                               | 0.143 | 0.292                  |
| 8  | 5                   | 0.10       | 0                               | 0.143 | 0.292                  |
| 9  | 8                   | 0.16       | 0                               | 0.143 | 0.292                  |
| 10 | 4                   | 0.08       | 0                               | 0.143 | 0.292                  |
| 11 | 10                  | 0.20       | 0                               | 0.143 | 0.292                  |
| 12 | 5                   | 0.10       | 0                               | 0.143 | 0.292                  |
| 13 | 8                   | 0.16       | 0                               | 0.143 | 0.292                  |
| 14 | 12                  | 0.24       | 0                               | 0.143 | 0.292                  |
| 15 | 5                   | 0.10       | 0                               | 0.143 | 0.292                  |
| 16 | 6                   | 0.12       | 0                               | 0.143 | 0.292                  |
| 17 | 4                   | 0.08       | 0                               | 0.143 | 0.292                  |
| 18 | 10                  | 0.20       | 0                               | 0.143 | 0.292                  |
| 19 | 7                   | 0.14       | 0                               | 0.143 | 0.292                  |
| 20 | 2                   | 0.04       | 0                               | 0.143 | 0.292                  |
| Total | 143 | | | | |

Figure 2. Control Chart of Defect Proportion
3.2. Result using pareto diagram
As known the amount of each defects based on the observation for 20 days taken from the field, the result of pareto diagram (see Figure 3) found out that broken runner and imperfect surface are types of defect which have high occurrence. Hence, recommended actions were more focused on these two types of defect.

![Pareto Diagram](image)

**Figure 3. Result of Pareto Diagram**

3.3. Result using five-whys analysis
Five-whys analysis is used to identify the root causes of defect problems in the injection production line and look for the best solutions for an improvement. The results of five-whys analysis are illustrated in Figure 4.

![Five Whys Diagram](image)
Based on the result of five-whys analysis (see Figure 4), we can infer that the root causes are categorized into four categories known as 4M as shown in Table 2 [13], [14].

**Table 2.** Root Causes Categorized in 4M

| No | Category | Causes or Problems | Corrective Actions |
|----|----------|--------------------|--------------------|
| 1  | Man      |                    |                    |
|    |          | 1. Workers don’t check on the machine setting thoroughly before operating it for the manufacturing process | 1. Briefings in each division before any shifts start to prevent misprocess in the manufacturing process |
|    |          | 2. Workers are not careful enough when moving the final products | 2. Put warning visual-boards and/or posters in the production line area |
|    |          |                    | 3. Apply the reward and punishment system based on result |
products

3. Workers are experiencing excessive fatigue
4. Workers don’t put silicon regularly on the molding as to slick the molding and help the injection molding process

|   | Material | Machine | Method |
|---|----------|---------|--------|
| 2 | Material | Machine | Method |
|   | The materials are not mixed well that caused the texture of raw materials too hard to be processed in the injection molding process | Temperature setting is too high that caused cracks due to an overheat | 1. There is no briefing before the shift starts 2. There is no material quality check |
|   | Specifying the procedures of the raw material quality check and make sure the workers check the material quality before a further process in injection molding | Checking the machine settings thoroughly before operating it for the manufacturing process | 1. Briefings in each division before any shifts start to prevent misprocess in the manufacturing process 2. Building a quality culture will not accept, not process, and not pass on defective product |

4. Conclusion
In order to maintain the quality of their products, this company decides to pay more attention in their actions to minimize the defects occurred from the production process. There are two ways to overcome this problem; preventive and repressive action. Preventive can be designed by (1) specifying the procedures of the raw material quality check before a further process in injection molding, (2) briefings in each division before any shifts start, and (3) put warning visual-boards and/or posters in the production line area for some important steps such as checking the machine settings thoroughly before operating it for the manufacturing process. In the other hand, repressive action itself is utilizing the defective products by crushing it using the crusher machine, which the crushed materials will be reused as secondhand product material with lower quality later on. These ways lead the company to reduce the waste and increase the product quality which obviously helps to get more recognition and maintain a good relation with the customers.

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