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Quality Control Analysis Using Flowchart, Check Sheet, P-Chart, Pareto Diagram and Fishbone Diagram

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ABSTRACT

SP Aluminum is engaged in the manufacturing industry by producing cooking utensils. In its application, SP Aluminum has tried to produce quality products to satisfy consumers. However, there are still defects that appear in its products. Another problem is the product defects have not been handled seriously by the company. Based on these problems, this study utilizes 5 quality control methods from seven tools: flowchart, check sheets, p-chart, Pareto diagram, and fishbone diagram. This research is a quantitative qualitative with direct data collection through observation and interviews. The data taken is the product defect in Super Wok Number 12. There are 49 defects data that have been processed. On the check sheet analysis, it was found that the intensity category of the product defects occurrence was obtained. Furthermore, control chart analysis shows that there are some of out-of-control data. Then, Pareto diagram analysis shows the most dominant types of defects are hole, dregs, and pores. Finally, the fishbone diagram shows that the factors of the absence of written SOPs, less thorough and less competent employees, poor working environment, lack of machine maintenance, poor handling of raw materials and inappropriate material handling processes were common causes of product defects.

***Keywords**: flowchart, check sheet, p-chart, pareto diagram, fishbone diagram*

1. INTRODUCTION

The increasingly advanced industrial world requires companies to improve continuously if they desire to exist and compete. These improvements can take the form of improving product and service designs, reducing production defects, service errors, more streamlined and efficient operating systems, faster customer responses, better employee skills and so on. One way to improve the company's performance is to reduce the level of defects that often occurs. The arising defects must be analyzed so that the potential causes of the problem and the solutions can be identified immediately. Consequently, continuous quality improvement attempts are necessary to defeat these challenges; hence, product quality can be maintained accurately (Hariyanto, 2017). Superior quality is the critical competitive advantage of every company (Anttila & Jussila, 2018). Through quality control, it is expected that the product can meet the specifications that have been set and can be accepted by consumers as well.

Quality control serves to keep a system effective in integrating quality development, maintaining quality, and improving the quality of products or services produced by the company, so that production and marketing can be at the most economical level, thus customers always get satisfaction (Prihantoro, 2012). Seven tools are the quality control tool that is widely used. Those are useful for mapping the scope of the problem, compiling data in diagrams to make it easier to understand, exploring various possible causes of problems and clarifying the authentic reality in a problem.

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Seven tools consist of seven control tools; there are check sheet, flowchart, control chart, scatter chart, histogram, Pareto diagram, and fishbone diagram (Syukron & Kholil, 2013).

SP Aluminum is one of the companies in Yogyakarta, which is engaged in the manufacturing industry, namely producing cooking utensils. In its application, SP Aluminum has tried to produce quality products to satisfy consumers. However, there are still defects that appear in SP Aluminum products. This can have an impact on waste and losses for the company. Another problem is that product defects that often occur have not been handled seriously and in depth by the company. So far, product defects are only repaired immediately and if they cannot be repaired, re-smelting will be carried out. Companies should apply quality control methods to analyze the causes of defects in products so that companies can take appropriate action.

Based on explanation above, this study discusses quality control in SP Aluminum by using several tools from seven tools. It aims to assist in determining further corrective actions so that the resulting product can be of high quality and acceptable to consumers.

2. METHOD

The method used in this research is quantitative qualitative with data collection carried out directly (observation in the field and direct interviews with related parties). The object under study is the defect in Super Wok Number 12. To perform the survey, 49 defects data are collected **from the first inspection process**. Based on the data obtained, data processing is carried out using several seven tools: flowchart, check sheet, p-chart, Pareto diagram and fishbone diagram.

3. RESULT AND DISCUSSION

This research focuses on Super Wok Number 12. Figure 1 shows flowchart of the wok production process at SP Aluminum. On the figure 1, it shows that the wok production process consists of three inspections. The first inspection is after the molding process, the second inspection is after the cooling process at room temperature and the third inspection is conducted after the turning process. Of the three inspections, the first inspection plays a very significant role because it requires high accuracy.

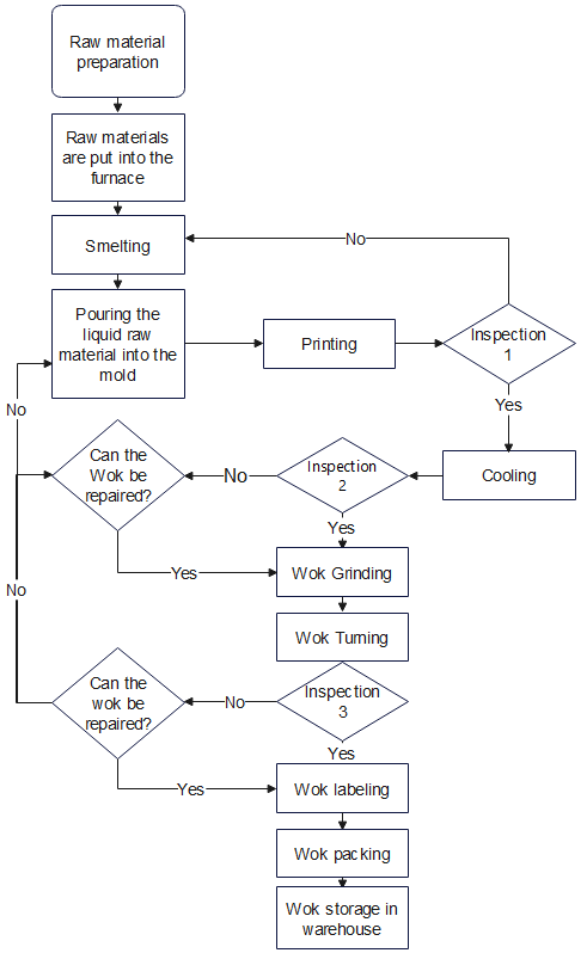

Figure 1. Production Process Flowchart
Source: Primary Data

If there are still many defective products passed on the first inspection, it will cause a lot of losses. Losses obtained can be in the form of process losses and loss of inventory costs when cooling the wok at room temperature. Therefore, the data that researchers process is data taken at the first inspection, namely after the printing process. From the data obtained, the researcher wants to know which types of defects are the most. For this reason, a check sheet is used to analyze it. Check sheet is a simple sheet that is used to record data systematically at the scene (Neyestani, 2017).

Table 1 is a check sheet for the types of product defects in Super Wok Number 12.

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Table 1. Check Sheet

#	Observations Number	Defects Number	Hole	Broken	Stain	Pores	Dregs	Climb	Cracked
1	240	45	16	3	1	2	15	4	4
2	230	56	10	1	7	7	23	5	3
3	220	51	3	0	5	13	20	4	6
4	254	73	20	0	6	12	24	3	8
5	213	51	13	2	2	9	17	6	2
6	139	33	13	0	1	4	12	2	1
7	98	24	6	0	2	5	8	2	1
8	223	69	28	3	6	8	17	1	6
9	213	46	19	2	3	6	9	3	4
10	227	37	12	1	5	3	12	2	2
11	158	24	11	0	1	2	7	2	1
12	198	28	13	2	2	1	9	0	1
13	244	37	14	0	3	6	11	0	3
14	237	61	14	0	2	7	21	3	14
15	212	70	29	0	3	2	23	6	7
16	223	51	14	0	2	5	17	7	6
17	250	43	17	1	3	4	13	3	2
18	232	54	23	0	1	2	20	2	6
19	294	88	31	1	6	13	24	8	5
20	418	108	45	1	4	4	36	5	13
21	452	53	28	0	2	3	16	2	2
22	471	63	21	3	1	6	24	7	1
23	339	90	38	3	5	11	23	6	4
24	428	82	25	2	7	13	21	5	9
25	269	22	7	0	1	7	6	0	1
26	86	12	4	0	1	2	4	0	1
27	158	36	13	2	3	6	7	2	3
28	233	80	29	3	7	9	17	4	11
29	71	18	11	2	0	2	3	0	0
30	246	39	20	3	1	3	7	2	3
31	125	24	10	0	1	5	7	0	1
32	77	9	3	0	0	1	4	1	0
33	42	7	4	0	0	1	2	0	0
34	59	28	6	1	3	4	7	5	2
35	161	51	33	4	2	2	6	3	1
36	125	63	39	8	0	4	8	1	3
37	222	30	17	0	2	3	7	1	0
38	201	34	21	0	1	3	6	0	3
39	229	37	9	0	1	5	9	5	8
40	199	42	11	0	9	6	10	4	2
41	193	28	11	0	5	6	4	0	2

Source: Primary Data

Based on the check sheet that has been made, data on the type and number of product defects are obtained. Furthermore, data will be processed and analyzed with other control tools. The next step, the researchers want to know the condition and control status of Super Wok Number 12. Therefore, the control chart method, P-Chart, is used to analyze it. P-Chart is the most popular control chart used by engineers to examine product defects (Abbas et al, 2020).
By using Ms. Excel, the P-Chart of Super Wok Number 12 is generated. The following is a graph of p-control map of the Super Wok Number 12 product:

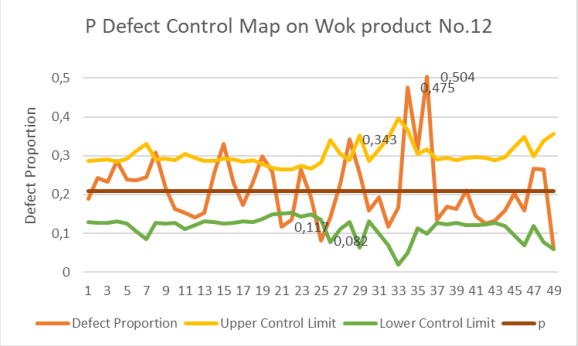

Figure 2. P-Chart

From this calculation, it can also be seen that the proportion of defects varies every day. P control chart is a quality control tool to determine the deviation (variation or deviation) of the proportion of defects in the production process (Lestari et al, 2018; Idris et al, 2021). From figure 2, there are the out-of-control data: the observation data 8, 15, 21, 22, 34, 35, 36.

The third step, the researchers want to know what types of defects are the most dominant during the research period. Therefore, the Pareto diagram method is used to analyze it. The table below shows the number of defects and the cumulative percentage value that will be used to create a Pareto diagram of Super Wok Number 12.

Table 2. Percent Type of Defects in Super Wok Number 12

#	Defect Type	Defect Total	Defect Percentage	Defect Cumulative Percentage
1	**Hole**	779	37%	37%
2	**Dregs**	572	27%	65%
3	**Pores**	241	12%	76%
4	**Cracked**	182	9%	85%
5	**Stain**	136	6%	91%
6	**Climb**	129	6%	97%
7	**Broken**	54	3%	100%
	Total	**2093**		

Source: Primary Data

Based on the data above, processing is carried out using a Pareto diagram. The following is the result of processing the types of defects in the production of Super Wok Number 12 with a Pareto diagram:

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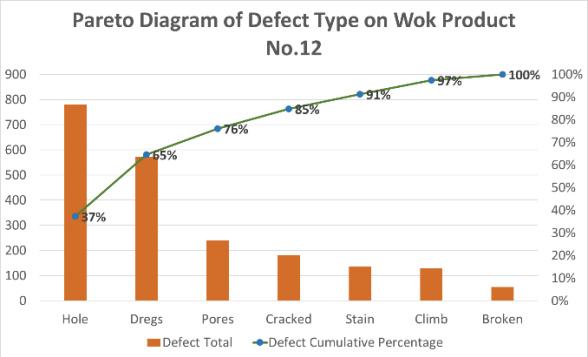

Figure 3. Pareto Diagram of Types of Defects in the Production of Super Wok Number 12

Pareto diagram is used to find out which types of defects must be treated immediately. From figure 3, it is obvious that the types of defects were holes with the number of defects as much as 779 or 37%, dregs with the number of defects as many as 572 or 27% and pores with the number of defects as much as 241 or 12%. The three types of defects are in accordance with the Pareto concept of 80%-20%, i.e., 80% of the problems are caused by 20% of the dominant causes (Harvey & Sotardi, 2018); therefore, the defects of hole, dregs, and pores must be addressed immediately.

After knowing the three types of defects on the Pareto diagram, it must be immediately handled by conducting an analysis using a cause-and-effect diagram (fishbone). Fishbone diagram were popularized by Dr. Kaoru Ishikawa in the 1960s (Rizan et al, 2020). This diagram is still incredibly common in various companies to be used as a tool to identify problems (Radziwill, 2017) as well as a tool to determine concrete actions at the root of the problem discovered (Liliana, 2016). By using this diagram, it will be easier to see the general causes to the specific causes of each defect. Here is a fishbone diagram of the three most common types of defects:

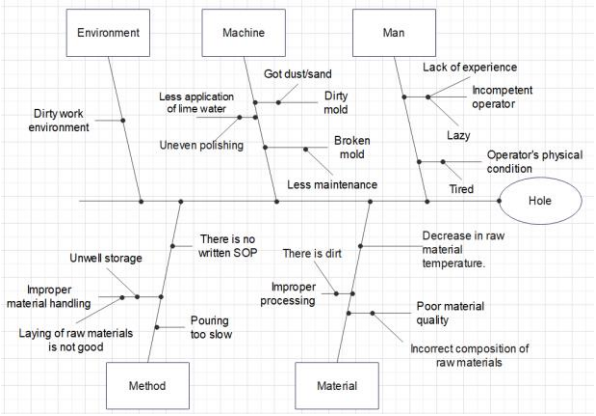

Figure 4. Fishbone Diagram Types of Hole Defects in Super Wok Number 12

Defects in the form of holes are caused by several factors. First, the human factor; the cause is the physical condition of workers who are not good, such as fatigue. Another factor is that workers are incompetent due to inexperience and laziness. Second, environmental factor; the cause is a dirty work environment and lack of lighting. Third, engine factor; in this context is the mold used. Therefore, the engine factor can be caused by the uneven application of lime water to the mold. Another cause is dirty molds due to exposure to dust or sand and damaged molds due to lack of maintenance. Fourth, the method factor, the cause is the absence of written SOPs, slow pouring duration and inaccurate material handling. So far, the manufacturing procedure has only been based on the experience and habits of employees. Finally, the material factor, in this case, aluminum is cooling; this happens because employees take too long to bring molten aluminum from the smelting furnace to the mold. Furthermore, the process of pouring molten aluminum is carried out in two different molds simultaneously which causes the pouring of molten aluminum in the second mold to cool, and holes will form. Then the material (raw material) undergoes oxidation on the surface. This happens because the temperature of melting aluminum is above its melting point so that at that time, molten aluminum will easily react with oxygen.

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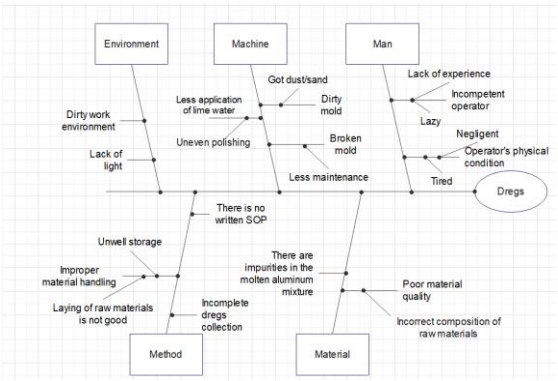

Figure 5. Fishbone Diagram Types of Dreg Defects in Super Wok Number 12

Dregs defects are caused by several factors. First, the human factor; the cause is the physical condition of workers who are not good such as tired and negligent. Another factor is that workers are incompetent due to lack of experience and laziness. Second, environmental factor; the cause is a dirty work environment and lack of lighting. Third, the engine factor; the machine here is the mold used. The cause of the engine factor is that the lime water is not evenly applied, the mold is dirty due to dust or sand, and the mold is damaged. Fourth, the method factor; included the absence of written SOP, inappropriate material handling, and incomplete pulp collection. Fifth, material factor; included the quality of the material is not good, there is dirt in the molten aluminum mixture. Apart from that, another material factor is molten aluminum reacting with air which happens because the melting temperature is above the melting point of aluminum. Under these conditions, molten aluminum reacts very quickly with the surrounding air. In addition, there is no checking of the combustion temperature for smelting.

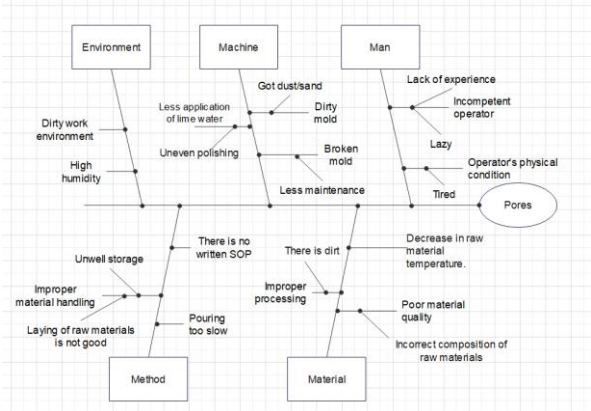

Figure 6. Fishbone Diagram Types of Pores Defects in Super Wok Number 12

Here are some factors that cause pore defects: first, the machine factor. The machine here is the mold used. The cause of the machine factor is due to the lack of water in the mold. Second, the method factor where there is no written SOP, pouring is too slow and material handling is not quite right. Third, the material factor, where the raw material has cooled due to continued pouring, the quality of the material is poor because the composition is wrong, and the processing is not good enough. Fourth, the human factor; the cause is the physical condition of workers who are not good such as tired and negligent. Another factor is that workers are incompetent due to lack of experience and laziness. Fifth, environmental factor, in this case the cause is a working environment that is dirty and has high humidity.

4. CONCLUSION

Based on the results of data processing by Pareto Diagram, the dominant types of defects in the production of Super Wok Number 12 are holes, dregs, and pores. Then, from P-Chart, the out-of-control data are on observation number 8, 15, 21, 22, 34, 35, 36 data. Furthermore, fishbone diagram shows that the factors that cause damage or defects in the production of Super Wok Number 12 are man, material, machine, method, and environment. Efforts to overcome the occurrence of defects caused by these factors can be carried out in the following ways: (1) man, including: supervise workers more regularly, provide training to workers on a regular basis, and creating a work appraisal system with the aim of motivating the performance of the workers to be better; (2) machines, including: checking machine readiness before and after use to conform to operational standards, perform machine maintenance correctly and periodically, not only when the machine is damaged, and careful mold making with good permeability, sufficient compaction, and sufficient vents; (3) materials, including: provide good standards for each raw material ordered and controlling raw materials prior to the printing process; (4) method, it is necessary to make a procedure manual so that the operator can understand and follow it as work instructions before carrying out the production process; the last is (5) environment, where it is necessary to maintain cleanliness in

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the work area so that the dirt on the work floor is not mixed with raw materials.

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