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Identification of flow mark defect on haitian MA 1200 machine in the molding process at PT. Philips Industries Batam

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ABSTRACT

PT Philips Industries Batam is a company engaged in the manufacturing sector. One of the production processes carried out at PT Philips Industries Batam is the molding process. In the industrial world, the molding process has several types of defects that can affect product quality. The highest number of defects was identified to find the root cause using the Pareto and Fishbone diagram. This research aims to identify the factors causing the defect. Parameters on the Haitian MA 1200 machine were identified to determine the cause of the flow mark defect, thereby improving the quality level of the produced products. From five trials, the optimal parameter setting value was found in the fifth trial. The parameter settings consist of the start post: inject 1 with a value of 63, inject 2 with a value of 42, pressure: inject 1 with a value of 165, inject 2 with a value of 155. Pressure: hold 1 with a value of 55, hold 2 with a value of 45, and flow: hold 1 with a value of 18 and hold 2 with a value of 13. The flow mark defect on the Haitian MA 1200 machine effectively decreased by adjusting certain parameters.

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1. INTRODUCTION

Plastic is now widely used in the production of a diverse range of products, from food packaging, toys, cosmetic containers, vehicles, electronics, and household appliances (Siti Qomariah & Agus Dani, 2023; Widiastuti, Surbakti, Restu, Albana, et al., 2019). In the industrial world, plastic is not only favored for its flexibility and ease of processing, but also for its ability to be modified and adapted to meet needs (Elapri et al., 2023). The plastics industry plays a crucial role in supporting the needs of various sectors, both in manufacturing and daily consumption. The growth of the plastic industry in Batam City is marked by high demand for plastic products. One company involved in this sector is PT Philips Industries Batam.

PT Philips Industries Batam Indonesia, which operates in the electronics industry (Fachrudin et al., 2024). This company produces electronic appliances, including razors. In the industrial world, production activities are inseparable from the use of tools or machines as operational support, one of which is a molding machine. The types of machines frequently used in the plastic pellet processing include compression molding machines, vacuum molding machines, blow molding machines, injection molding machines, and extrusion machines. The machine is used in processing plastic granules into plastic products (Wibawansyah & Akbar, 2024). Injection molding technology now plays a crucial role in the modern manufacturing industry (Jayasankar et al., 2025). Injection molding is one of the common production methods used in the manufacturing of various types of plastic products (Elapri et al., 2023; Ikhwan & Yuliastuti, 2024).

Injection molding is a manufacturing method for producing plastic goods or components, involving the process of molding and shaping plastic material to the required size and form (Elapri et al., 2023). A mold is one of the main components in the injection molding process, playing a role in shaping the molten material into the product form according to the design (Suparya & Anjani, 2024). This mold consists of two parts: a movable plate and a stationary plate (Arif et al., 2024; Widiastuti, Surbakti, Restu, Albana, et al., 2019). This method offers various advantages, including the ability for large-scale production, high precision levels, diverse material choices, minimal waste generation, fast production times, and cost-effective repetitive manufacturing processes (Arif et al., 2024; Kosasih et al., 2023). Nevertheless, products produced by injection molding machines sometimes still show defects in their results (Lase & Arwati, 2025; Wibawansyah & Akbar, 2024). Residual stresses are inherent in components encapsulated by molding processes (Phansalkar et al., 2022). The key to producing higher quality products in injection molding is proper injection speed, pressure, and mold design (Selvaraj et al., 2022).

During industrial processing, unforeseen defects may arise in products due to uncontrollable factors (Lei et al., 2023). In industrial manufacturing processes, errors frequently occur at unpredictable times and in unknown manifestations (Rudolph et al., 2022). Some examples of defects commonly found in the injection molding process are: short mold, flashing, sink marks, flow marks, color streaks, bubbles, weld lines, black spots, and warpage (Mourya et al., 2023). Flow marks are defects in a product that appear as line patterns on its surface (Yanto et al., 2018). The flow mark defect occurs because the flow of material injected into the mold is not optimal (Nur Huda et al., 2024). This defect occurs when the flow of liquid material is uneven, leaving marks on the surface of the finished product. This defect is commonly caused by two factors: parameter settings and material (Widiastuti, Surbakti, Restu, Hasan Albana, et al., 2019). Various types of materials commonly used in the injection molding production process include HDPE (High Density Polyethylene), PP (Polypropylene), and ABS (Acrylonitrile butadiene styrene). ABS is a type of plastic composed of three monomers: Acrylonitrile, butadiene, and styrene. It has advantages such as being hard, rigid, resistant to chemicals and heat, and easy to mold (Iman Mujiarto, 2005). Research conducted by Ikhwan and Yuliastuti reported that flow marks were present in ABS material (Ikhwan & Yuliastuti, 2024). In the electronics industry that uses injection molding, ABS more frequently experiences flow mark defects compared to other plastic materials such as PP or PE under the same processing conditions (Regi & Tosello, 2019), due to its relatively higher viscosity and relatively lower flowability, making it sensitive to changes in melting temperature and injection speed. Based on the description, this research aims to identify the factors causing flow mark defects.

PT Philips Industries Batam was selected as the case study due to its high production volume, use of injection molding technology, ABS-based products manufacturing, well-documented process data, and operation in the electronics sector, which requires high standards of quality. The scope of this research is limited to identifying parameters on the Haitian MA 1200 machine with flow mark defects on products and ABS (Acrylonitrile butadiene styrene) materials. The initial stage of this research is to collect data from the production department by interviewing technical staff to identify the frequent flow mark defects that occur on the Haitian MA 1200 machine during the production process.

2. RESEARCH METHOD

Before starting this research, the first thing to do is to describe the process flow chart. The flow chart is very important in determining the initial steps for conducting the research. The flow chart diagram of the implementation stages can be seen in Figure 1.

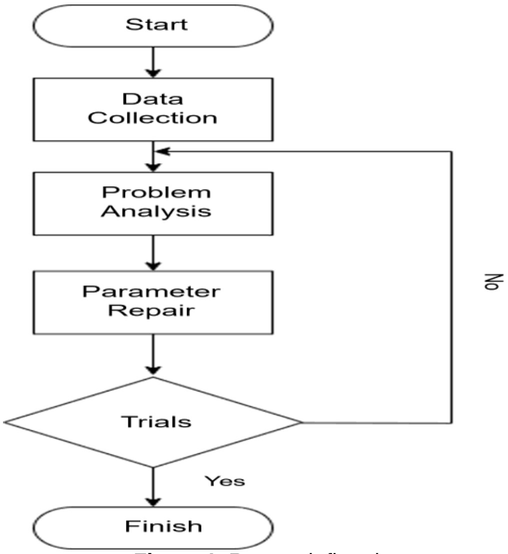

Figure 1. Research flowchart

The plastic material used in the production process with the Haitmanan MA 1200 molding machine employed by PT. Philips Industries Batam is Acrylonitrile Butadiene Styrene (ABS). Figure 2 shows the type of ABS plastic used in the production process.


Figure 2. Acrylonitrile butadiene styrene (ABS) material

Figure 3 shows the molding machine used by PT. Philips Industries Batam, namely the Haitian MA 1200 machine. In the process of converting plastic ore from ABS material, it is melted at a temperature of 180°C to 240°C (Iman Mujiarto, 2005).

Figure 3. Haitian MA 1200 molding machine
(https://www.cmmachinery.com.my/wp-content/uploads/Haitian-Mars-Series-MA-1200_410.jpg)

The initial stage conducted in this research is data collection to identify the factors causing the defect. Then, problem analysis is performed using Pareto and fishbone diagrams, which serve as the basis for identifying the root of the problem. The next step is to repair the parameters of the Haitian MA 1200 machine and conduct a repair test by comparing the results of the obtained parameters.

The QC 7 tools are the problem-solving technique employed in this study. The two components of the QC 7 tools method are as follows:

a. Pareto Diagram, a Pareto diagram is a type of bar chart that is used to rank issues. To show the comparison of data on a specific topic, the bar chart's lines are connected. Pareto analysis is a technique for ranking different possibilities in order to determine which ones should be given priority (Gunawan & Tannady, 2016; Holifahtus Sakdiyah et al., 2022). The Pareto method is used when the total defects exceed 20% of 80% of the total defect data in a production process. The Pareto diagram works by displaying the highest defect results in the form of a table and creating a graph on the Pareto diagram. The purpose of using the Pareto diagram is to identify the highest defects in the Haitian MA 1200 machine and to find solutions to reduce those defects (Hairiyah et al., 2019).
b. Fishbone diagram, a cause-and-effect graph that illustrates the connection between a problem and its contributing factors is called a fishbone diagram. Because of its structure's resemblance to fish bones, this graphic is termed a fishbone. This diagram consists of a fish head on the right, which represents the peak of the problem, and the fishbone section shows the factors causing the problem. The factors causing the problem include: Man, material, machine, method, and environment (Aristriyana & Ahmad Fauzi, 2023; Handes et al., 2013; Kumah et al., 2024).

3. RESULTS AND DISCUSSIONS

To identify the cause of the flow mark defect on the Haitian MA 1200 machine, a Pareto chart was used as an analysis tool and a fishbone diagram to determine the root cause of the problem on the Haitian MA 1200 machine.

Defects Generated by the Haitian MA 1200 Machine

Data about defects was obtained from the Haitian MA 1200 machine. The highest defect serves as a reference for taking the next steps in reducing the number of defects on the Haitian MA 1200 machine. Table 1 shows data on several defects in the machine from December 2023 to February 2024.

Table 1. Data on various defects in the haitian MA 1200 machine

Data on various defects in the machine from December 2023 to February 2024				
No	Defect type	Quantity	Persentase	Persentase kumulatif
1	Flow mark	127	57.99%	57.99%
2	Short molding	32	14.61%	72.60%
3	Flashing	27	12.33%	84.93%
4	Sink mark	16	7.31%	92.24%
5	Bubble	12	5.48%	97.72%
6	Weld line	5	2.28%	100.00%
	Total	219	100.00%	

From Table 1, it can be concluded that the flow mark defect is the most common defect with a quantity of 127 defects. There have also been reports of flow mark defects in the molding machine when ABS plastic is used (Ikhwan & Yuliastuti, 2024). Flow mark is a product defect characterized by flow lines or streaks that have a negative impact on the product. The defect shows up when there is an irregular flow of liquid material, which leaves marks on the part's surface. Numerous factors, including as machine capacity, mold shape, plastic material, and parameter settings, are typically responsible for this problem. The parameters include cooling time, injection pressure and speed, injection and filling time, material melting temperature, ejection pressure, mold temperature, and melt speed (Arif et al., 2024; Devalia & Arief, 2019; Ikhwan & Yuliastuti, 2024). An example of a flow mark defect can be seen in Figure 4.

Figure 4. Flow mark defects

Pareto Diagram

This is the defect data from the Haitian MA 1200 machine from December 2023 to February 2024. this data is analyzed using a Pareto diagram. The Pareto diagram can be seen in Figure 5.

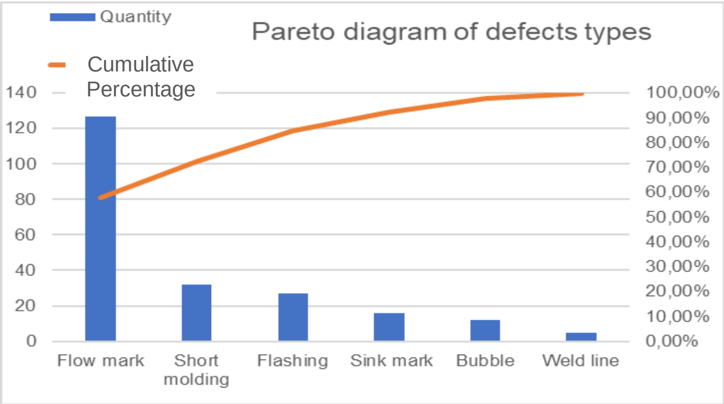

Figure 5. Pareto diagram

From this Pareto diagram, it can be seen that the highest percentage of cumulative defects is the flow mark defect with a total of 127 defects. This diagram yields a proportion of 57.99% out of the 100% total number of defects. The defects identified through the 80/20 Pareto method show a percentage value exceeding 20%, which is a main requirement in seeking solutions to reduce defects.

Fishbone Diagram

The fishbone diagram is used to analyze the problems that occurred previously, which can be seen in the Pareto chart. The fishbone diagram in this study is shown in Figure 6.

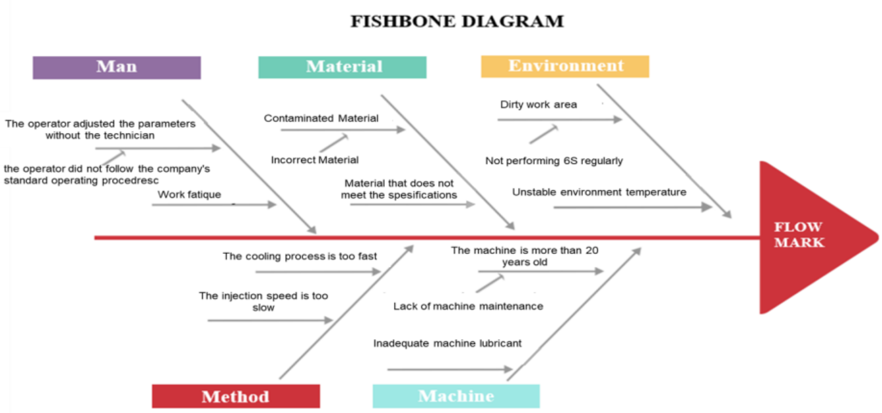

Figure 6. Fishbone diagram

Figure 6 shows that the issue is caused by five distinct factors. The issue is caused by man, material, machine, method, and environmental factors. The use of the fishbone diagram is analyzed with components labeled "NO" and "YES," and the purpose of these components is to identify the causes of the flow mark defect. Table 2 shows the root cause analysis based on the fishbone diagram.

Table 2. Root cause analysis

Factors	Hypothesis	Verification	Root cause?
MAN	- The operator deliberately adjusted the parameters without the technician.	- Giving a warning to the operator not to do that again.	NO
MATERIAL	- Contaminated material - Material not in accordance with specifications	- Labeling materials with standards that meet the company's standard operating procedures	NO
ENVIRONMENT	- Dirty work area - Unstable environmental temperature	- The clean machine area was observed on-site in accordance with company standards - Based on the report, the average room temperature over 7 days is 35^{0}C	NO
METHOD	- The cooling process is too fast - The injection process is too slow	- Adjusting data on the parameters and testing with the new parameters	YES
MACHINE	- The machine is more than 20 years old. - Insufficient lubrication of machines	- Create a weekly preventive maintenance checklist to be carried out. - Giving grease to the Haitian machine	NO

The potential interaction between the factors of method, machine, material, and man can be analyzed using a fishbone diagram to map the causes of existing problems based on the results of field testing and direct observation. From the analysis above, it can be seen that the method factors (cooling and injection processes) are the main causes contributing to the flow mark defect, labeled "YES". Meanwhile, other factors, although tested and analyzed, were not proven to be the main causes, thus labeled "NO". This helps in determining a more precise and effective focus for improvement efforts.

Repair of Machine Parameter

The initial parameter settings before being repaired can be seen in Figure 7. The repair of these parameters is carried out after the cause of the flow mark defect is identified, which is the parameter, therefore the next step is to adjust the data in the parameter settings.

Parameter Injection Molding

	Injec #6	Injec #5	Injec #4	Injec #3	Injec #2	Injec #1
Start Pos	-	-	-	9	39	59
Pressure	-	-	-	150	150	160
Flow	-	-	88	44	11	7
Switch Mod	Press	Pos	Timer			
Threshold	Pres Threshold (0)	Pos Threshold (30.0)	Time Threshold (0.1)			
	Hold #6	Hold #5	Hold #4	Hold #3	Hold #2	Hold #1
Pressure	-	-	-	-	43	50
Flow	-	-	-		13	18
Time	-	-	-	1	2	5

Figure 7. The initial parameter settings before being repaired

Table 3 shows 5 trials of adjusting injection molding parameters on the Haitian MA 1200 machine in an effort to eliminate flow mark defects.

Table 3. Experiment on injection molding parameter adjustment

	Injection molding parameter on the Haitian MA 1200 machine														
	Experiment 1			Experiment 1			Experiment 1			Experiment 1			Experiment 1		
Inject	Inject 3	Inject 2	Inject 1	Inject 3	Inject 2	Inject 1	Inject 3	Inject 2	Inject 1	Inject 3	Inject 2	Inject 1	Inject 3	Inject 2	Inject 1
Start Pos	9	39	66	9	40	61	11	35	62	9	39	59	10	42	63
Presure	149	150	153	150	150	160	150	155	159	150	150	160	150	155	165
Hold		Hold 2	Hold 1		Hold 2	Hold 1		Hold 2	Hold 1		Hold 2	Hold 1		Hold 2	Hold 1
Presure		43	50		46	50		43	50		43	50		45	55
Flow		13	18		14	18		13	18		14	20		13	18

Based on the results of five trials of injection molding parameters listed in Table 3, effective parameter settings were obtained to improve the flow mark defect. This optimal setting consists of start post settings: inject 1 with a value of 63, inject 2 with a value of 42, pressure settings: inject 1 with a value of 165, inject 2 with a value of 155, and pressure settings: hold 1 with a value of 55, hold 2 with a value of 45, as well as flow settings: hold 1 with a value of 18 and hold 2 with a value of 13. These parameter settings successfully reduced the flow mark defect on the Haitian MA 1200 machine.

During the 5 trials, the researchers took product samples with the new parameter settings to check for the flow mark defect. Upon checking the samples, no flow mark defects were discovered. By applying the correct repair parameters, the test results showed the absence of flow mark defects after the repair process. This indicates the effectiveness of the implemented repair method in addressing the issue. The achievement demonstrates the importance of accurate parameter settings in ensuring the final product quality. Thus, the corrective actions taken have yielded satisfactory results and improved the overall integrity of the product. A key factor in improving product quality and reducing defects is parameter optimization in the injection process for plastic materials (Lase & Arwati, 2025). Additionally, Changes in injection molding process parameters may also affect mechanical strength and esthetics such as gloss and other defects (Ozcelik et al., 2010; Tsai et al., 2009). However, this is not the focus of this research.

4. CONCLUSION

In the industrial process, the identification and handling of defects such as flow marks are crucial for improving product quality. This study identifies flow mark defects on the Haitian MA 1200 machine using initial parameters consisting of start post settings: inject 1 with a value of 59, inject 2 with a value of 39, pressure: inject 1 with a value of 160, inject 2 with a value of 150, pressure: hold 1 with a value of 50, hold 2 with a value of 43, and flow: hold 1 with a value of 18 and hold 2 with a value of 13, followed by parameter repair with five trials.

The ideal parameter settings—start post: inject 1 with a value of 63, inject 2 with a value of 42, pressure: inject 1 with a value of 165, inject 2 with a value of 155, pressure: hold 1 with a value of 55, hold 2 with a value of 45, and flow: hold 1 with a value of 18 and hold 2 with a value of 13—were determined after a total of five attempts of parameter adjustments. The parameter adjustments successfully fixed the flow mark defect on the Haitian MA 1200 machine.

This research makes an important contribution to the field of defect identification in the production process. With optimal parameter settings, it is hoped that the industry can be more effective in reducing the number of products with flow mark defects, thereby increasing productivity and reducing production costs due to defects. The elimination of flow mark defects serves as a basis for setting standard parameters, implementing routine monitoring, integrating optimization into maintenance and training, and reducing defect costs to improve long-term productivity and efficiency in the company. Paying attention to optimal parameters as a basis and making gradual adjustments while observing product quality is necessary for optimal results on different types of molding machines or materials. The differences in machine characteristics and material properties must be considered to eliminate flow mark defects without introducing new defects.

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