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Reducing Painting Defects on Mining Vehicle Vessel at PT XYZ Through PDCA Method and Phenomenology Method

Muhamad Pedro[1], Iqmal Syawaludin[2*], Eza Andriyanto[3], Bulbul Danil[4], Syaiful Umam[5], Yudi Prastyo[6]
[1,2,3,4,5,6]*Department of Industrial Engineering, Pelita Bangsa University, Bekasi, Indonesia*

***Abstract*: Waste of defect, is waste that occurs due to poor quality or product damage, poor painting quality can also be used as a reason for consumers not to buy and choose a product based on the above, we will make a Scientific Paper with the title "Reducing Painting defects in mining vehicle vessels at PT XYZ". The research method used is a mixed method, which combines quantitative and qualitative research, quantitative research with the PDCA Approach (Plan, Do, Check, Act), qualitative research with the phenomenology method, researchers collect data related to this research, among others, are painting process production data and data on the results of checking in the QC painting section. From these data, sagging is the most common defect in the painting process of mining vehicle vessels at PT XYZ for the period June 2024 - October 2024. To find the main cause of defects, then displayed through a fishbone diagram, based on these causes, the researcher plans to take corrective actions in the PT XYZ painting vessel production process area. The result of the improvements made is the reduction of sagging defects in the painting vessel process from an average of 6 sagging defect points to 0 sagging defect points.**

***Keywords*: production, PDCA, phenomenology, defect, painting, sagging.**

1. Introduction

In the development of the mining industry which is increasingly rapid, modern, and prioritizes safety, PT XYZ is required to always improve the quality of its products. This is important to do to maintain consumer confidence, and to maintain the continuity of work. One important aspect that is a challenge at PT XYZ is cost, or production cost.

The cost increases due to one aspect, namely waste, which in manufacturing terms is an activity that does not add value to the product, but consumes other resources such as people and energy. Waste of defect, is waste that occurs due to poor quality or product damage. So that additional costs are needed for repairs. These defects occur in the painting process on mining vehicle vessels, which has an impact on reducing production capacity and increasing production costs.

The quality of the painting results on mining vehicles is very important, because the painting results are one of the consumer assessments in determining whether the mining vehicle product is good or bad. In addition, poor painting quality can also be used as a reason for consumers not to buy and choose a product.

Based on the above, we aim to find out the causes of painting defects in mining vehicle vessels, with this aim we make a Scientific Paper with the title "Reducing Painting defects in mining vehicle vessels at PT XYZ".

2. Theoretical Review

A. Production Process

The production process can be defined as a structured series of activities that transform inputs into value-added outputs. According to Stevenson (2021), the production process involves the combination of resources such as labor, equipment, raw materials, and information to create products or services that meet market needs. This process includes not only physical production activities but also the provision of services that involve the transformation of information or customer experience.

The production process is a series of steps or activities that transform raw materials into final products through the use of resources, including people, technology, and facilities. This process can be categorized into continuous and intermittent production processes, depending on the nature of demand and the type of product.

One important principle in the production process is continuous improvement. This approach emphasizes the importance of always looking for ways to improve the production process, whether in terms of efficiency, quality, or waste reduction. Methods often used in continuous improvement include the PDCA (Plan, Do, Check, Act) cycle, which helps in identifying problems, testing solutions, and implementing improvements systematically.

B. Defect

Production defects or defects are the result of a production process that does not meet predetermined quality standards. Production defects can be caused by a variety of factors, including human error, machine malfunction, unsuitable raw materials, or non-optimal environmental conditions during the production process. Defects can be divided into two main categories: major defects (critical defects that make the product

*Corresponding author: syawaludiniqmal@gmail.com

unfit for use) and minor defects (defects that affect the aesthetics but do not affect the main function of the product).

According to Heizer and Render (2020), a defect is a product that does not meet the set specifications making it unfit for delivery to customers. Defects are often the main cause of reduced product quality and waste of resources.

1) Quality and Defect Theory

Total Quality Management (TQM) emphasizes on defect prevention rather than correcting after defects occur. TQM focuses on improving quality throughout the production process by involving all levels of the organization.

Kaizen is a continuous improvement philosophy that underscores the importance of defect prevention through small, consistent improvements in operational processes.

C. Painting

The painting process is one of the final stages in the manufacturing process that aims to provide a protective and aesthetic layer on the surface of the product. Painting can be done manually or automatically using spray painting, electrostatic painting, or powder coating techniques. A good painting process not only produces an attractive appearance but also provides protection against corrosion, weather exposure, and chemical damage.

According to Russel and Taylor (2022), the success of the painting process depends on several factors such as:

1) Surface Quality

Surface preparation before painting, such as cleaning and sanding, is essential to ensure the paint adheres well.

2) Application Technique

The use of appropriate painting tools and techniques, such as spray angle, distance, and air pressure, greatly affects the final result.

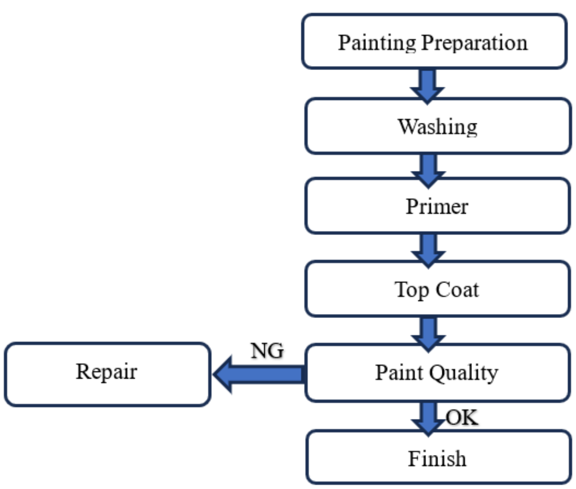


Fig. 1. Painting process flow

D. Painting Defects

Painting defects are imperfections that occur in the paint layer during or after the painting process. These defects often result from factors such as inadequate surface preparation, incorrect painting techniques, or poor environmental conditions during painting.

According to Nasution (2015), painting defects can be categorized into several types, including:

- *Blistering:* Bubbles that appear in the paint layer due to air or water vapor trapped below the surface.
- *Orange peel:* An uneven paint surface resembling an orange peel, which is usually caused by improper spraying techniques.
- *Saging:* Paint drips or runs down the surface of the product due to overly thick paint application or incomplete drying.
- *Cracking:* Cracks that appear in the paint layer due to the use of incompatible materials or drying too quickly.

Tjiptono & Diana (2018) painting defects can be identified and analyzed using quality control tools such as Fishbone Diagram or Pareto Chart to determine the main causes and priorities in solving defect problems.

3. Research Methods

Mixed method, which combines quantitative and qualitative research, quantitative research with the PDCA method (Plan, Do, Check, Act). While qualitative research with phenomenological methods, namely data collection through in-depth interviews with painting operators to understand technical problems, constraints, and working conditions that can cause defects. After obtaining the required data, then the researcher will process the data in the hope of finding the right solution, so that it can reduce or even eliminate the highest NG in the painting process.

A. PDCA (Plan, Do, Check, Action)

PDCA in Indonesian means planning, doing, checking, and following up. This corporate management model was coined by Walter Shewhart and developed by W. Edwards Deming with the aim of improving the company or individual process. Because of this, PDCA is often called the Deming cycle, Shewhart cycle, or control cycle. This cycle is widely used in manufacturing companies, management companies, etc.

B. Phenomenology

Phenomenology is the science (logos) of what appears (phenomena). Phenomenology as such, is a science that studies, or what appears phenomenon. Phenomenology comes from the Greek language which etymologically, the term phenomenon or phaenesthai, means to bring up, elevate, show itself.

The phenomenological approach focuses on subjective experience. This approach relates to personal views of the world and interpretations of the various events they face. Thus using a phenomenological approach to conduct research can help find out the causes behind the occurrence of defects or defects in products, by considering the operator's experience of the causes of defects.

C. Data Collection

Researchers collect data related to this research, including painting process production data and checking data in the QC painting section for the period June 2024 to October 2024. The data will be displayed in tabular form, so that it will make it easier for researchers to understand the data and further analysis can be carried out.

Table 1
List quantity data of defects

Month	Type	Defect	Qty	Month	Type	Defect	Qty	Month	Type	Defect	Qty
June	105ss	Sagging	6	August	105ss	Sagging	6	October	105ss	Sagging	5
		Blister	2			Blister	1			Blister	2
		Overspray	2			Overspray	2			Overspray	1
		Pin hole	1			Pin hole	0			Pin hole	2
		Orange peel	3			Orange peel	3			Orange peel	1
		Dust	2			Dust	1			Dust	1
		Peel off	0			Peel off	1			Peel off	0
		Gloss	0			Gloss	0			Gloss	0
Month	Type	Defect	Qty	Month	Type	Defect	Qty				
July	105ss	Sagging	5	September	105ss	Sagging	6				
		Blister	1			Blister	3				
		Overspray	2			Overspray	1				
		Pin hole	2			Pin hole	1				
		Orange peel	3			Orange peel	4				
		Dust	1			Dust	0				
		Peel off	1			Peel off	0				
		Gloss	1			Gloss	1				

Based on the defect data in the data collection stage, a histogram is made to determine the types of defects that occur most in the painting process at PT XYZ.

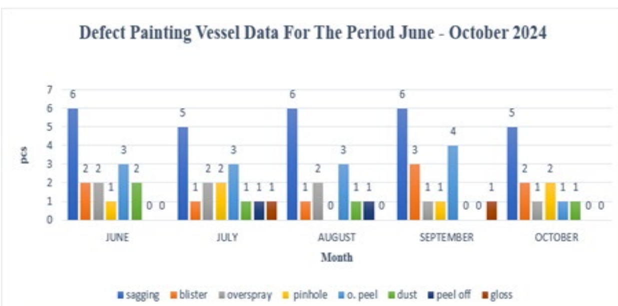


Fig. 2. Histogram table list quantity defect

From the histogram figure above, it can be concluded that defect painting sagging is the defect that occurs most in the process of painting mining vehicle vessels at PT XYZ for the period June 2024 - October 2024. There is an average of 6 defecr painting sagging per month which must be repaired painting process.

D. *Phenomenology*

After discussions with experienced operators and accompanied by further monitoring of the vessel painting process on mining vehicles at PT XYZ, conclusions were obtained from the opinions of the operators regarding the causes of sagging on mining vehicle vessels:

1. Improper spray gun atomizer
2. Taking too long to spray at one point
3. Production area that is not up to standard
4. Paint mixture that is too thick or too thin

After the researcher collected opinions from the operators and monitoring was conducted, the researcher then applied the PDCA method to eliminate the source of the problems that had been collected both from the operators' opinions and the researcher's monitoring.

E. *PDCA*

To get the desired results from this study, researchers applied the PDCA method to eliminate the source of the sagging defect problem.

1) *Planning Phase (Plan)*

In this phase, researchers planned the actions needed to eliminate painting defects with the main focus on eliminating sagging.

2) *Implementation Phase (Do)*

In this phase, researchers implement corrective actions that focus on the painting process. By focusing on the results of operator opinions and researcher monitoring.

3) *Evaluation Phase (Check)*

After the researcher implements the actions taken to eliminate the defects that occur, then the researcher evaluates the results of the corrective actions that have been taken. To find out whether the actions taken can effectively reduce defects that have occurred.

4) *Follow-up Phase (Action)*

Perform further actions based on the results of the evaluation phase, and select actions that successfully eliminate defects that occur.

F. *Creating a Fishbone Diagram*

To make it easy to study and read the data quickly, the data will be presented in the form of a histogram, which is a visual data presentation tool in the form of a block graph showing the distribution of the values obtained. Then, the data will be analyzed using a fishbone diagram to determine the exact cause of the NG.

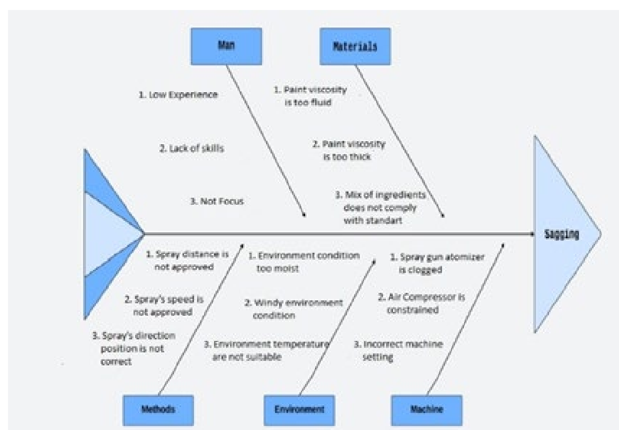


Fig. 3. Fishbone diagram

4. Results and Discussion

A. *Planning Phase*

Based on phenomenology, the causes of sagging defects are:

- Improper spray gun atomizer
- Taking too long to spray at one point
- Production area that is not up to standard
- Paint mixture that is too thick or too thin

Based on the fishbone diagram and direct observation of researchers, the causes of sagging defects include:

- *Man:* Lack of experience, lack of skill, not focused when working.

- *Material:* Non-standard paint viscosity, non-standard mixing of materials.
- *Machine:* Clogged atomizer, abnormal wind pressure, abnormal machine.
- *Methods:* Non-standard spray distance, non-standard painting speed.
- *Environment:* The environment is too moist, windy, abnormal ambient temperature.

Based on these causes, the researcher planned to take the following corrective actions:

a. Conducting the spray process in the painting room with the appropriate blower conditions, in order to avoid the risk of sagging due to wind.
b. Conducting the spraying process with a standard distance of 20-30 cm from the vessel, also with the appropriate speed so that the paint does not accumulate in one location.
c. Mixing the paint materials in accordance with the predetermined standards, by ensuring the accuracy of the dosage of each material so that the paint is not too thin or too thick.
d. Performing the Air-Assist Airless Gun settings appropriately, such as the appropriate wind pressure of 0.4-0.6 MPa, as well as ensuring the spray shape is appropriate to avoid paint ejection from the spray inappropriately.

B. *Implementation Phase*

After planning the corrective actions, the researchers implemented the actions that had been determined in the hope of eliminating the occurrence of defects, especially sagging. Researchers carried out the implementation of corrective actions in the last 2 weeks of November. The following are the actions taken by researchers and operators during the painting process:

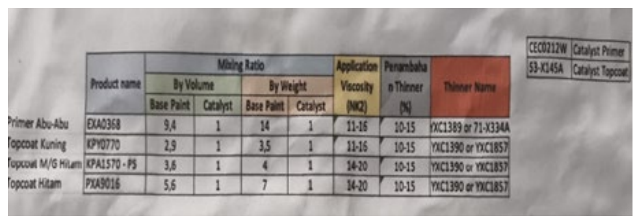
a. Perform the painting process in the painting room with appropriate wind blower conditions.

Fig. 4. Indoor painting process

b. Spray at an appropriate distance, as well as at an appropriate spray speed.

Fig. 5. Spray painting distance

c. The process of mixing paint materials in accordance with predetermined standards, by ensuring the accuracy of the dosage of each material so that the paint is not too thin or too thick.



	Product name	Mixing Ratio				Application Viscosity (NK2)	Penambahan Thinner (%)	Thinner Name
		By Volume		By Weight				
		Base Paint	Catalyst	Base Paint	Catalyst			
Primer Abu-Abu	EXA0368	9,4	1	14	1	11-16	10-15	YXC1389 or 71-X334A
Topcoat Kuning	KPY0770	2,9	1	3,5	1	11-16	10-15	YXC1390 or YXC1857
Topcoat M/G Hitam	KPA1570 - PS	3,6	1	4	1	14-20	10-15	YXC1390 or YXC1857
Topcoat Hitam	PXA9016	5,6	1	7	1	14-20	10-15	YXC1390 or YXC1857

CEC0212W	Catalyst Primer
53-X145A	Catalyst Topcoat

Fig. 6. Paint mix measure

The standard dosage for top coat paint process is top coat paint material added with thinner by 10 - 15% then add hardener by 3.5 parts of the total weight of top coat paint + thinner. The picture below is an example with a weight of 75.3 grams of top coat paint material.

Fig. 7. Top coat paint weight

Added thinner weighing 10-15% of the weight of the top coat paint material. So that it becomes 97.8 grams.

Fig. 8. Weight of top coat paint + thinner

This mixture is then added with hardener as much as 3.5 of the top coat material with thinner. Then the result of the top coat paint process mixture will be 240 grams.

Fig. 9. Weight of hardener +top coat +thinner

Fig. 10. Air-assist airless gun setting

This is the standard dosage for the Top Coat painting process. Perform proper Air-Assist Airless Gun settings, such as the appropriate wind pressure of 0.4-0.6 MPa, as well as ensuring the spray shape is appropriate to avoid paint ejection from the spray inappropriately.

C. Evaluation Phase (Check)

Researchers conducted an evaluation after the implementation of improvements in the PT XYZ Vessel Painting production area. Researchers compared the data from checking the painting vessel process before and after the implementation of improvements.

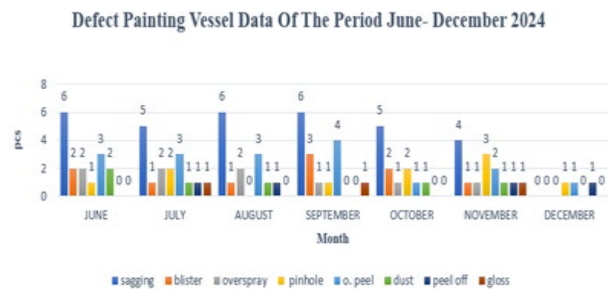


Fig. 11. Histogram table of defect quantity list

In figure 11, we can see the evaluation results of the improvements in the PT XYZ painting vessel production area in December 2024. Before the research related to painting vessel defects, there were an average of 6 painting sagging defects in the painting vessel process each month. After research and implementation of improvements, painting sagging defects in the painting vessel process can be reduced to 0.

D. Follow Up Phase (Act)

To follow up on the evaluation of the research, and to maintain the results of the improvement implementation that the researchers have done, all improvement implementations will be standardized in the Work Instruction of the painting vessel production process.

5. Conclusion

From the research results, sagging is the most common NG that occurs in the painting process of mining vehicle vessels at PT XYZ for the period June 2024 - October 2024. The causes of sagging on mining vehicle vessels include:

- Improper atomizer spray gun.
- Taking too long to spray at one point.
- Production area that is not up to standard.
- Paint mixture that is too thick or too liquid.

Based on these causes, the researcher planned to carry out corrective actions as follows:

- Conduct the spray process in the painting room with a blower condition with appropriate wind, to avoid the risk of sagging due to wind.
- Spraying process with a standard distance of 20-30 cm from the vessel, with an appropriate speed so that the paint does not accumulate in one location.

- Mixing paint materials in accordance with predetermined standards, by ensuring the accuracy of the dosage of each material so that the paint is not too thin or too thick.
- Setting the Air-Assist Airless Gun appropriately, such as the appropriate wind pressure of 0.4-0.6 MPa, by ensuring the spray shape is appropriate to avoid paint ejection from the spray inappropriately.

Based on the actions that have been taken by researchers, the results obtained are:

- Reduced sagging defects in the mining vehicle painting vessel production process.
- Standardization of painting proses.

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