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# REDUCTION OF DEFECT RATE IN THE LINE MAINTENANCE INSPECTION PROCESS USING SIX SIGMA METHOD IN AN INDONESIAN AIRLINE.

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## ABSTRACT

An airline in Indonesia conducted an average of 21 inspection activities on 99 Boeing Series aircraft during the period from January 2024 to June 2024. The company aims to improve efficiency by reducing the number of inspections to 5 activities per aircraft. This study aims to determine the current sigma level, identify the root causes of the high number of inspection occurrences, evaluate the outcomes of the implemented solutions, and determine the sigma level after the improvements. The research employs Six Sigma methodology and 5W1H. The results indicate that the primary causes of defects were insufficient training for engineers/mechanics, poor component quality, and outdated inspection tools. After implementing corrective actions such as retraining, updating SOPs, replacing low-quality components, and upgrading inspection tools, defects were reduced from 2,055 occurrences on 99 aircraft to 400 occurrences on 73 aircraft. Consequently, the DPMO decreased from 104,309 to 27,534.93, and the sigma level improved from 2.796 to 3.214. This study demonstrates that a systematic Six Sigma approach can enhance efficiency and quality in aircraft maintenance.



## Introduction

The aviation industry is a sector that heavily relies on high safety and reliability standards to prevent failures that could lead to serious incidents [1]. Pressure from international regulations and customer expectations drives airlines to improve aircraft maintenance processes continuously [2]. With increasing competition, operational efficiency and defect reduction have become top priorities to ensure business sustainability and enhance global competitiveness [3].

Line inspections within the line maintenance division of an airline play a crucial role in ensuring the safety and operational reliability of aircraft. These inspections involve routine, light checks conducted

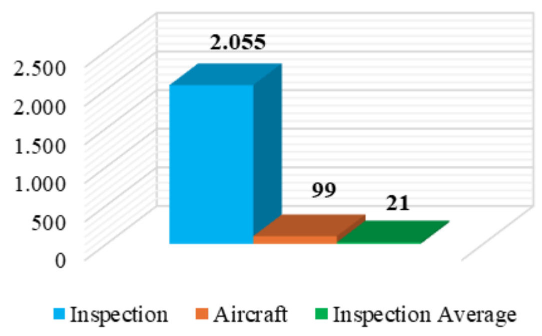


Figure 1. Inspection Activity January - June 2024

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between the aircraft's arrival and departure at the airport [4]. They include visual checks, inspections of navigation equipment, and the identification of potential defects or malfunctions that could impact flight safety, as well as ensuring the aircraft's readiness for its next flight [5].

The inspection report from an airline for the period of January 2024 to June 2024 indicates that there were 2,055 inspection activities conducted on 99 aircraft, resulting in an average of 21 inspections per aircraft (Figure 1). The company aims to reduce the number of inspections to 5 per aircraft during line inspections. In the study by Rochmawati & Fahma (2016), the application of the Six Sigma method successfully reduced defects in the cabin components of Boeing 737-800 aircraft, explicitly lowering the defect level for placards to 3.73 and for tables to 3.83. Meanwhile, research by Warinah & Nusraningrum (2019), demonstrated that the number of defects in five Critical to Quality attributes was reduced from 3,898 to 2,056, raising the sigma level from 4.16 to 4.39. Based on this phenomenon, this research aims to determine the current sigma level, identify the root causes of the high frequency of inspections, evaluate the implementation of solutions, and measure the sigma level after improvements.

## Methods

The data analysis technique, once all data has been collected, is processed using the DMAIC method and Root Cause Analysis. The detailed sequence of processes is as follows (Figure 2):

1. *Define*

The initial activity involves defining the objectives of the engineering practice, specifically focused on reducing the defect rate in the inspection process. This step ensures that activities remain focused and stay consistent with the main goal [8].

2. *Measure*

This measurement phase is crucial for obtaining objectivity regarding the existing problems through several activities, including the following [9]:

a. Calculating the sample size

The sample size in this study is calculated using Equation 1:

$$n = \frac{N.Z^2.p.(1-p)}{\left((N-1).d^2\right) + (Z^2.p.(1-p))} \quad (1)$$

Where N is the number of aircraft in the reporting period (99 units), Z is the confidence level score of 1.96 (from the table for a 95% confidence level), $p$ is the proportion of 0.5, and $d$ is the margin of error of 5%. Substituting the values into the formula yields a sample size of 79 aircraft, rounded to 80 samples.

b. Calculating Defect Opportunities:

$D_r = Q\ .D_o$Defect opportunities are calculated using Equation 2:

$$D_r = Q\ .D_o \quad (2)$$

Where $D$ is the Defect rate in the inspection process, Q is the number of aircraft units and $D_o$ is the Defect opportunities per aircraft unit.

c. Calculating Current DPMO

The defect per million opportunities (DPMO) is calculated to determine the sigma level before improvement, using Equation 3[10]:

$$DPMO = \left(\frac{\Delta D}{D_r}\right).10^6 \quad (3)$$

Where DPMO is Defects per million opportunities, ΔD is the number of inspection defects, $D_r$ is the Defect rate in the inspection process.

The conversion of DPMO to the sigma level can be seen in Table 1 [11].

Table 1. DPMO to Sigma Level

| DPMO | Sigma Level | Percent Meeting |
|---|---|---|
| 500.000 | 1,5 | 50,0000% |
| 308.500 | 2 | 69,1500% |
| 158.700 | 2,5 | 84,1300% |
| 66.800 | 3 | 93,3200% |
| 22.700 | 3,5 | 97,7300% |
| 6.210 | 4 | 99,3790% |
| 1.350 | 4,5 | 99,8650% |
| 230 | 5 | 99,9770% |
| 3,4 | 6 | 99,9997% |

3. *Analyze*

The analysis process uses a fishbone diagram to develop comprehensive solutions to address the problems [12]. This activity is carried out through Focus Group Discussions consisting of members from the Working Group, PPC, and Engineering teams, each with over five years of work experience [13].

4. *Improve*

The improvement phase involves several steps, such as [14]:

a. Finding solutions using the 5W + 1H method (What, Why, Who, When, Where, and How) [15].

b. Calculating Future DPMO using Equation 2.

c. Comparing Future DPMO and Current DPMO

This comparison is conducted to assess the effectiveness of the implemented solutions using the DPMO indicator [16]. If the post-improvement DPMO is lower than the pre-improvement DPMO, the improvement is considered successful, and further control mechanisms are established [17]. If the post-improvement DPMO is higher, the process returns to the analysis and improvement stages [18].

5. *Control*

This phase involves developing control procedures based on the improvement results, oriented toward Statistical Process Control (SPC) [5]. Daily reporting is conducted to monitor and take corrective actions if values exceed the Upper Control Limit (UCL) or fall below the Lower Control Limit (LCL) [19].

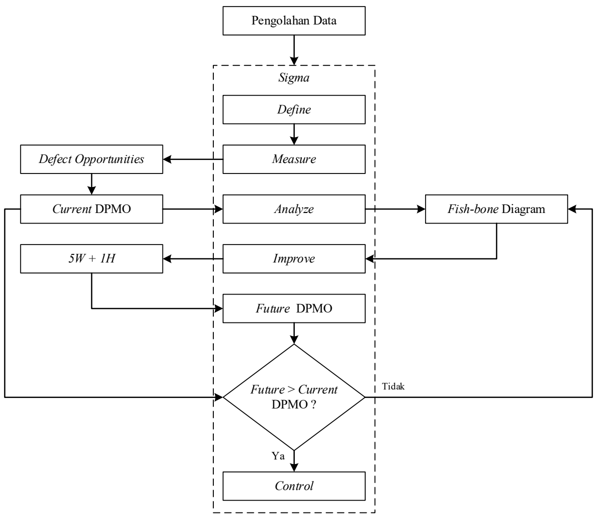



Figure 2. Research Flow Process

**Results and Discussions**

In one of the maintenance divisions of an Indonesian airline, the primary responsibility is to perform aircraft maintenance and servicing to ensure smooth service operations [20]. The bottleneck in the maintenance process lies in the inspection phase, which has a deterrent effect on subsequent processes, including troubleshooting, repair/replacement, operational testing, and commissioning [21]. Therefore, the quality of the inspection process plays a crucial role in ensuring that all subsequent procedures are completed effectively [22]. The Six Sigma method is used to eliminate quantitative deficiencies and identify the root causes of issues within the inspection process. The stages for implementing Six Sigma include Define, Measure, Analyze, Improve, and Control [23].

**Define**

Define is the initial stage in identifying the problems to be addressed in this research. The critical components of this stage include:

***SIPOC Diagram***

SIPOC stands for Supplier, Input, Process, Output, and Customer, and it outlines the flow of the business process from the supplier to the customer, moving from left to right. The SIPOC diagram for this research is presented in the table.

***Critical to Quality (CTQ)***

Critical to Quality is a component within the Define phase that serves as a key element to help the organization identify specific customer requirements and establish a benchmark for quality improvement in line inspections. The results of the CTQ analysis for this research are presented in Figure 3.

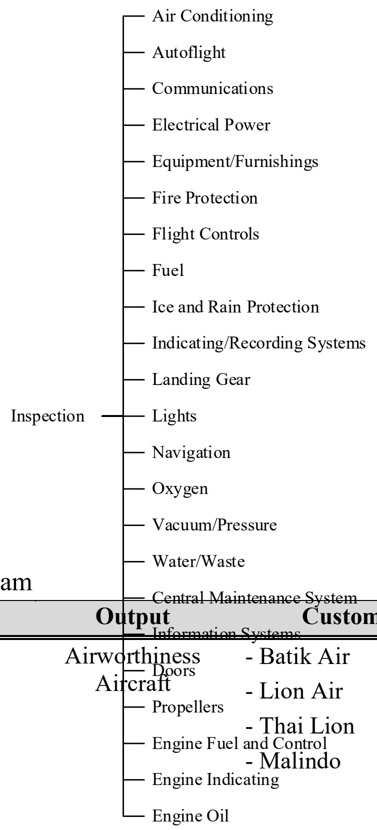



Table 2. SIPOC Diagram

| Supplier | Input | Process | Output | Customer |
|---|---|---|---|---|
| - Batik Air<br>- Lion Air<br>- Thai Lion<br>- Malindo | Trouble Aircraft | Maintenance<br>- Inspection<br>- Troubleshoot<br>- Repair/ Replacement<br>- Operational Test<br>- Comisioning | Airworthiness Aircraft | - Batik Air<br>- Lion Air<br>- Thai Lion<br>- Malindo |

Figure 3. CTQ of Inspection

## Measure

The Measure phase aims to evaluate the current quality condition of the company's line inspection activities using several methods, including:

***Defect per Million Opportunities (DPMO)***

Before calculating the defect per million opportunities, an initial data check is performed through normality tests to determine whether the data distribution is normal. The results of the normality tests for the inspection activities are shown in Figure 4.

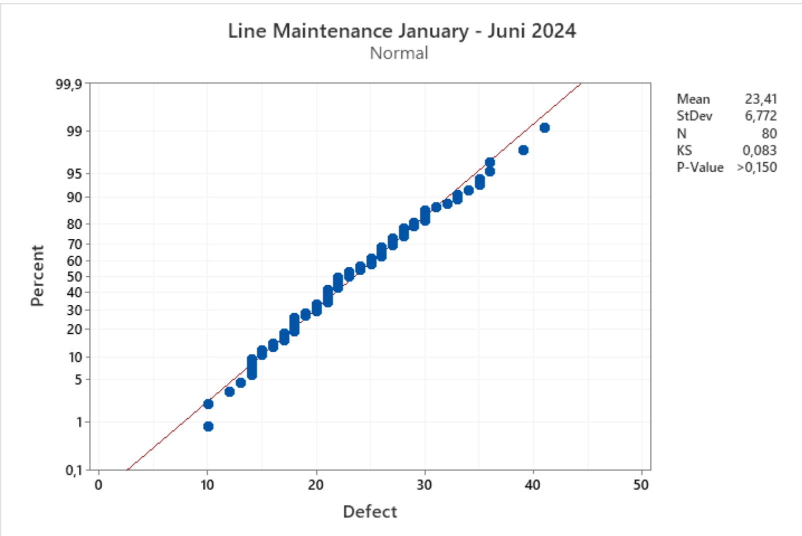
In Figure 4 (a), the Anderson-Darling normality test produced a p-value of 0.578, which is greater than 0.05, indicating that the data follows a normal distribution.

In Figure 4 (b), the Kolmogorov-Smirnov test resulted in a p-value greater than 0.150, confirming that the data is usually distributed.

Having established that the data is usually distributed through the Anderson-Darling and Kolmogorov-Smirnov tests, the next step is to calculate the defect per million opportunities as follows:

1. Calculate defect opportunities using Equation 1


(a)




(b)

Figure 4. Normality test for Inspection Line: (a) Anderson-Darling; (b) Kolmogorov-Smirnof

$$D_r = Q \, . D_o$$

$$D_r = 99 \, . 199 \; = 19.701 \; defect \; opportunities$$

Based on the calculation, the defect opportunities for 99 Boeing Series aircraft amount to 19,701.

2. Calculate Current DPMO using Equation 2 by substituting the defect opportunities result:

$$DPMO = \left(\frac{\Delta D}{D_r}\right) . 10^6$$

$$DPMO = \left(\frac{2.055}{19.701}\right) . 10^6 = 104.309,43$$

The initial DPMO before improvement is 104,309 defects per million opportunities. Using Table 1 to convert this value, the corresponding sigma level is 2.796 sigma.

***Control Chart***

The Control Chart provides an overview of the defects occurring due to suboptimal inspection processes. Table 3 details the number of defects encountered in each inspection activity conducted on 99 aircraft over the period from January 2024 to June 2024.

Table 3. Defect Inspection January - June 2024

| No | ATA Chapter Inspection | Oppurtinities | Defect |
|---|---|---|---|
| 1 | Air Conditioning | 990 | 217 |
| 2 | Autoflight | 792 | 200 |
| 3 | Communications | 1.485 | 207 |
| 4 | Electrical Power | 1.188 | 33 |
| 5 | Equipment/Furnishings | 1.980 | 238 |
| 6 | Fire Protection | 693 | 36 |
| 7 | Flight Controls | 495 | 184 |
| 8 | Fuel | 891 | 37 |
| 9 | Ice and Rain | 1.089 | 40 |
| 10 | Indicating/Recording Systems | 1.386 | 174 |
| 11 | Landing Gear | 594 | 44 |
| 12 | Lights | 1.782 | 253 |
| 13 | Navigation | 2.178 | 230 |
| 14 | Oxygen | 396 | 23 |
| 15 | Vacuum/Pressure | 297 | 27 |
| 16 | Water/Waste | 495 | 21 |
| 17 | Central Maintenance | 198 | 30 |
| 18 | Information Systems | 297 | 18 |
| 19 | Doors | 594 | 12 |
| 20 | Propellers | 396 | 14 |
| 21 | Engine Fuel and Control | 495 | 2 |
| 22 | Engine Indicating | 693 | 6 |
| 23 | Engine Oil | 297 | 9 |
| | ***Total*** | ***19.701*** | ***2.055*** |

After obtaining the data presented in Table 3, the next step is to create a control chart using Minitab. The results are shown in Figure 5.

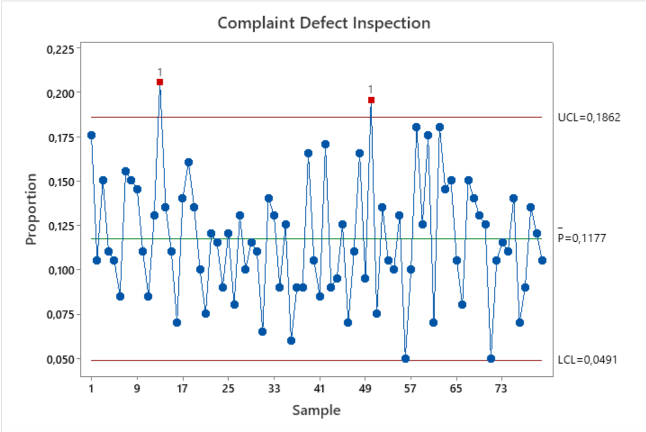



Figure 5. Control Chart Inspection Process January - June 2024

Based on the plotted chart in Figure 5, data points marked as boxes with a value of 1 that fall outside the Upper Control Limit (UCL) and Lower Control Limit (LCL) indicate that the inspection process in those areas is not optimal and requires improvement.

**Analyze**

***Pareto Diagram***

Based on the results of the data processing for the types of inspection defects classified by ATA *(Air Transport Association)* for the period from January 2024 to June 2024, the details are provided in Table 4.

Table 4. Complaint Defect Inspection

| System | Defect Qty | Percentage | Cumulative |
|---|---|---|---|
| Lights | 253 | 12,311% | 12,311% |
| Equipment/Furnishings | 238 | 11,582% | 23,893% |
| Navigation | 230 | 11,192% | 35,085% |
| Air Conditioning | 217 | 10,560% | 45,645% |
| Communications | 207 | 10,073% | 55,718% |
| Autoflight | 200 | 9,732% | 65,450% |
| Flight Controls | 184 | 8,954% | 74,404% |
| Indicating/Recording Systems | 174 | 8,467% | 82,871% |
| Landing Gear | 44 | 2,141% | 85,012% |
| Ice and Rain | 40 | 1,946% | 86,959% |
| Fuel | 37 | 1,800% | 88,759% |
| Fire Protection | 36 | 1,752% | 90,511% |
| Electrical Power | 33 | 1,606% | 92,117% |
| Central Maintenance | 30 | 1,460% | 93,577% |
| Vacuum/Pressure | 27 | 1,314% | 94,891% |
| Oxygen | 23 | 1,119% | 96,010% |
| Water/Waste | 21 | 1,022% | 97,032% |
| Information Systems | 18 | 0,876% | 97,908% |
| Propellers | 14 | 0,681% | 98,589% |
| Doors | 12 | 0,584% | 99,173% |
| Engine Oil | 9 | 0,438% | 99,611% |
| Engine Indicating | 6 | 0,292% | 99,903% |
| Engine Fuel and | 2 | 0,097% | 100,000% |

Based on the data in Figure 6, it is identified that the most frequent defects to be mitigated using a fishbone diagram in the line inspection process

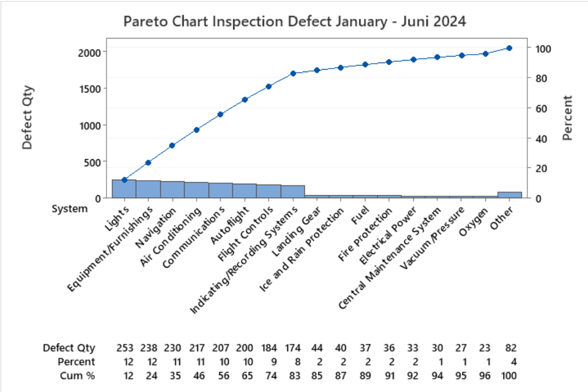



Figure 6. Pareto Diagram of Complaints Defect January - June 2024

include:

1. Lights
2. Equipment/Furnishings
3. Navigation
4. Air Conditioning
5. Communications
6. Autoflight
7. Flight Controls
8. Indicating/Recording Systems

***Fishbone Diagram***

The fishbone diagram is used to explore the problems identified from the Pareto analysis to gain a broad perspective for developing solutions in subsequent stages using the 5W1H method. The creation of the fishbone diagram was carried out through Focus Group Discussion (FGD) involving experts with more than five years of work experience from the Working Group, PPC, and Engineering. During this activity, all participants contributed to identifying various problem causes based on their own experiences. The results of the FGD were then validated through the judgment of an Engineer with over twenty years of experience in the field of Aircraft Maintenance. The fishbone diagrams for the eight identified problems are presented in Figures 7-14.

Based on the Fishbone Diagram analysis, it is evident that the primary causes of defects in the aircraft maintenance process are multifaceted, involving a combination of human, component, tool, method, and environmental factors, which include:

1. Human Factors

Issues commonly found across all categories include inadequate training and high levels of operator fatigue, often exacerbated by ineffective supervision and high work pressure. These human factors lead to errors, negligence, and improper handling of systems or equipment.

2. Component Quality

Many defects originate from the use of low-quality or non-durable components, resulting in frequent component failures. Problems such as sensor degradation, weak structures, and short component lifespans highlight the need for improved supplier management and the use of more durable materials.

3. Tools and Equipment

The analysis indicates that outdated, inaccurate, or inadequate tools significantly contribute to defects. The need for calibration and routine maintenance of diagnostic and repair tools reduces the effectiveness of inspections and repairs.

4. Method Gaps

Unclear, outdated, or poorly structured Standard Operating Procedures (SOPs), along with ineffective inspection methods, lead to inefficiencies and errors. The lack of routine updates, inadequate documentation, and ineffective audit processes further exacerbate these issues.

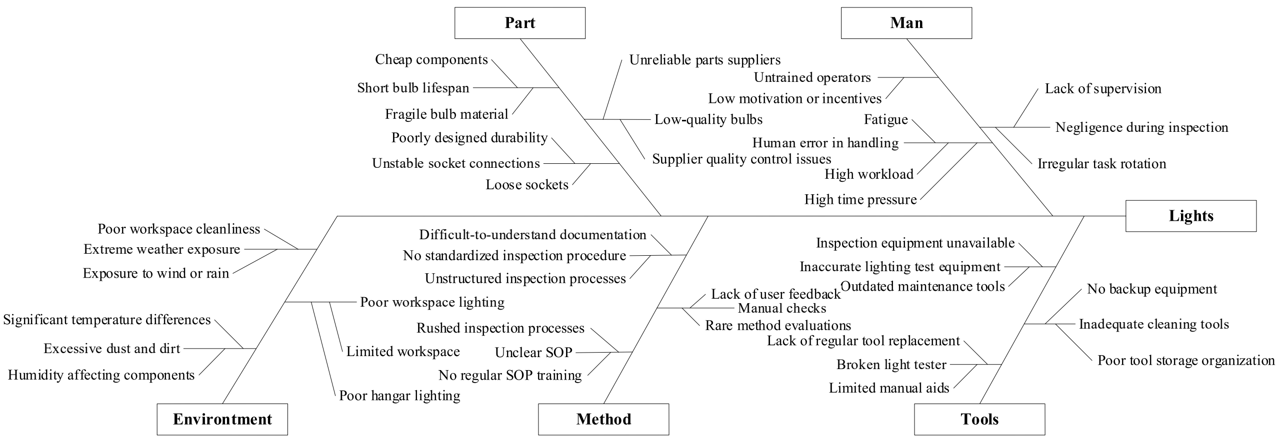



Figure 7. Fishbone Diagram of Lights Defect

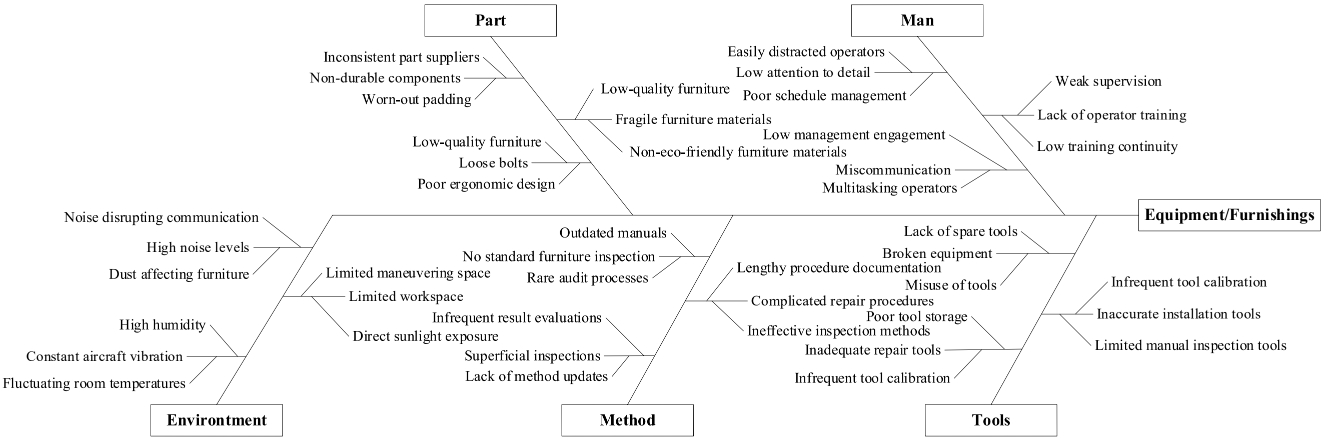



Figure 9. Fishbone Diagram of Equipment Defect

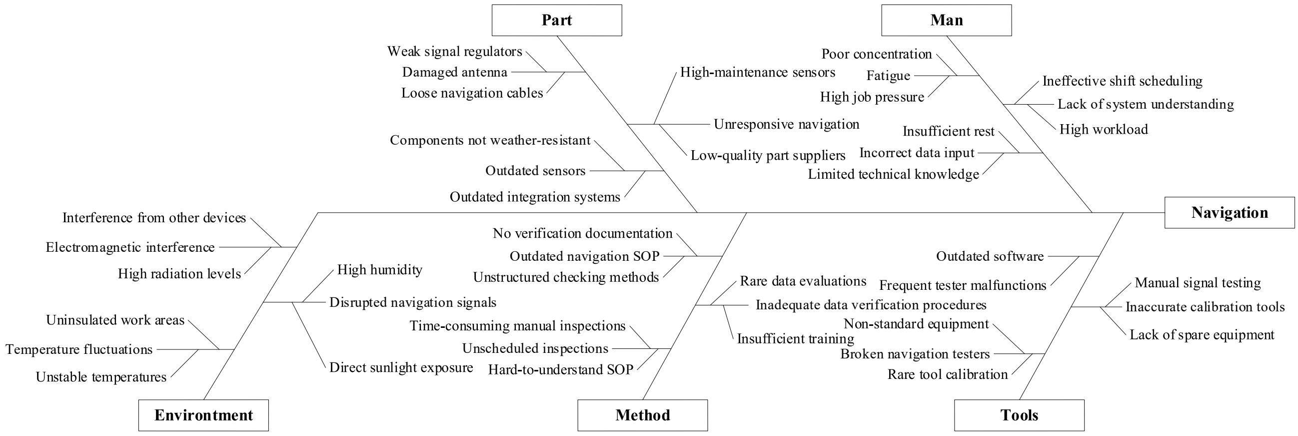



Figure 8. Fishbone Diagram of Navigation Defect

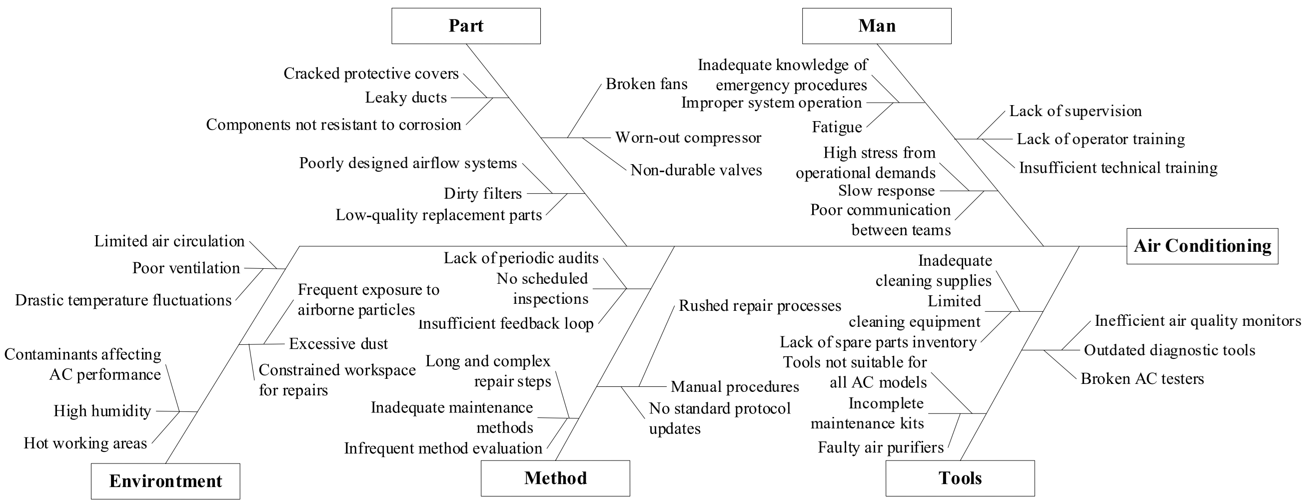



Figure 10. Fishbone Diagram of Air Conditioning Defect

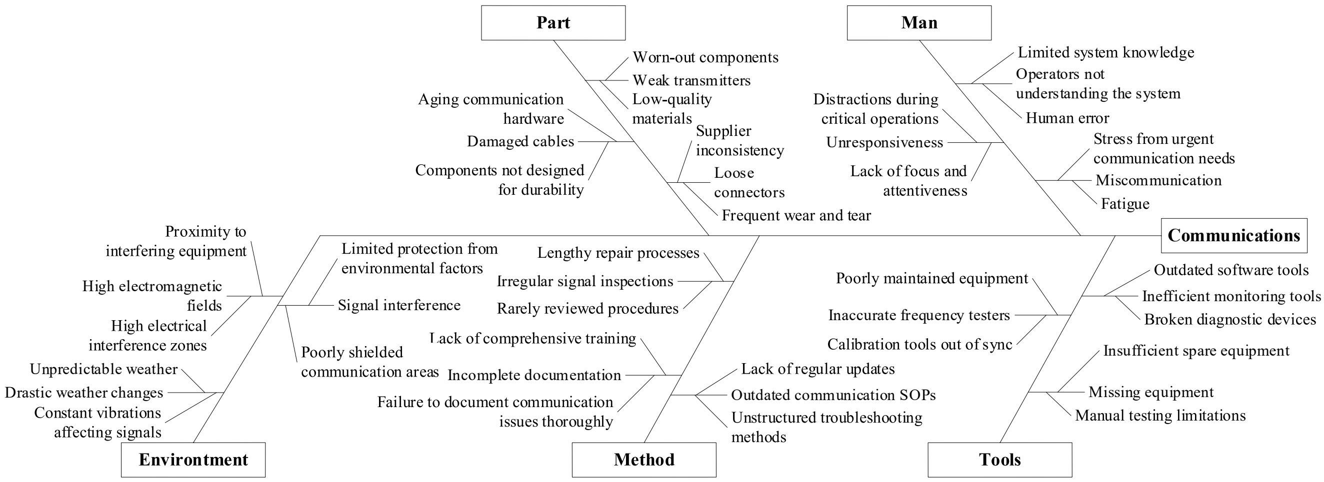



Figure 11. Fishbone Diagram of Communication Defect

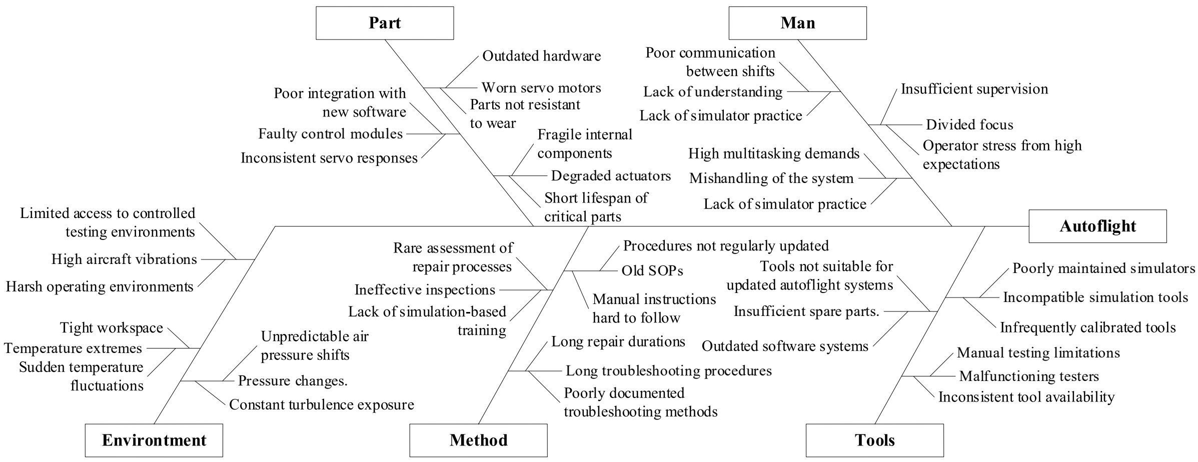



Figure 12. Fishbone Diagram of Autoflight Defect

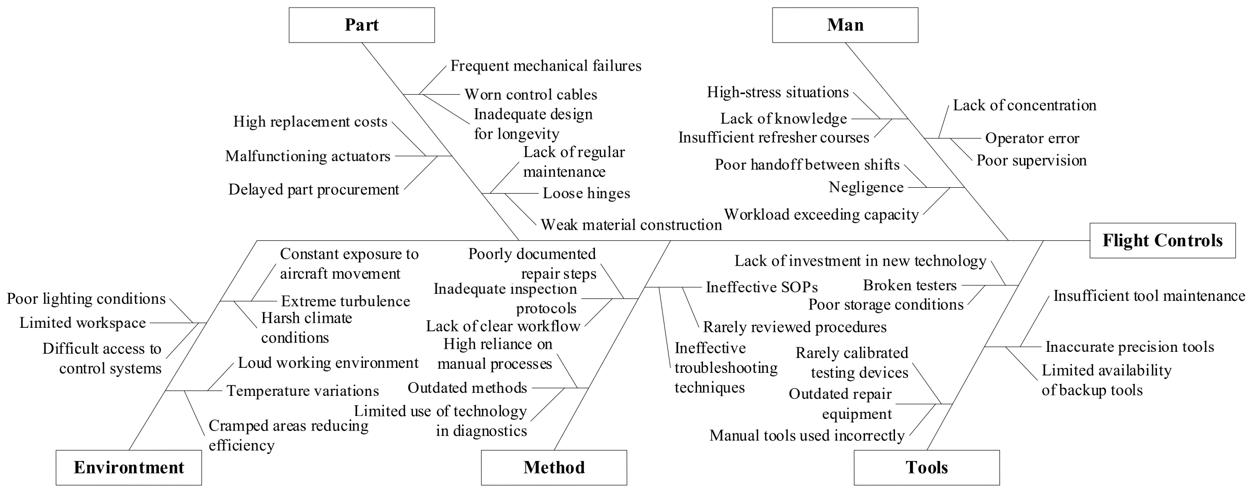



Figure 13. Fishbone Diagram of Filight Controls

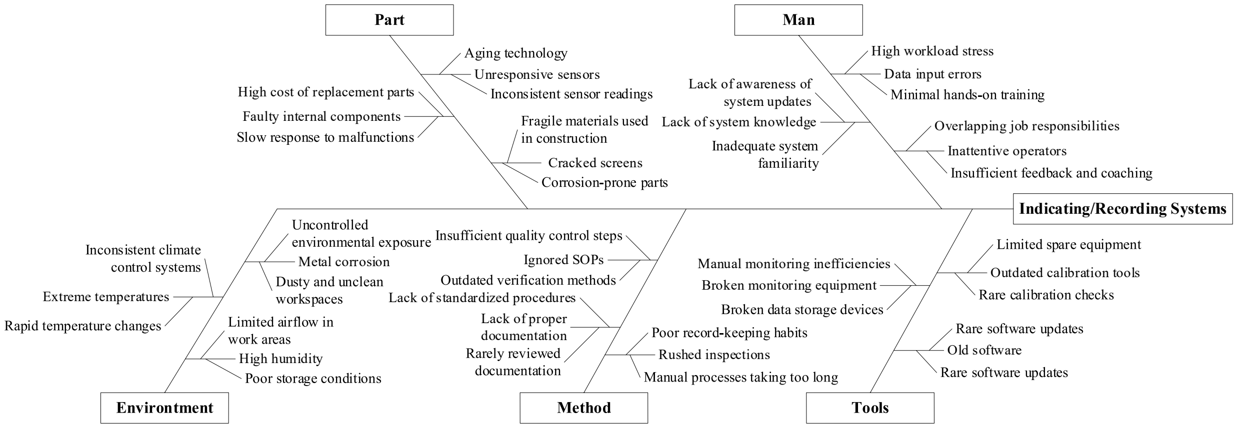



Figure 14. Fishbone Diagram of Indicating/ Recording System Defect

5. Environmental Challenges

Environmental conditions, such as high humidity, extreme temperature fluctuations, poor ventilation, and continuous exposure to outdoor elements, negatively impact component performance and the working conditions of maintenance personnel.

## Improvement

The 5W+1H method (What, Why, Who, When, Where, and How) is used in improvement activities to find solutions to the various root causes identified in the fishbone diagram. This improvement activity is conducted through Focus Group Discussions (FGDs) involving different participants who have over five years of work experience and are from the Working Group, PPC, and Engineering departments. These FGDs are held at different times from the root cause analysis sessions. The results of this activity are presented in Table 5-12.

Based on Table 5-12, it is evident that the solutions focus on structured and comprehensive improvements, targeting the leading causes identified in the Fishbone analysis. These strategies include:

1. Enhancing Human Resource Competency
   Improved training and supervision to ensure operators can perform tasks effectively and minimize errors.
2. Improving Component and Material Quality
   Using higher-quality, durable materials and components to reduce the frequency of failures.
3. Utilizing Advanced and Well-Maintained Tools
   Ensuring that modern diagnostic and maintenance tools are optimally used to support inspections and repairs.
4. Refining Standard Operating Procedures
   Updating and simplifying SOPs to increase efficiency and accuracy in the maintenance process.
5. Adjusting the Work Environment
   Improving working conditions to reduce the negative environmental impact on system performance and personnel safety.

The implementation process for the improvement activities based on the proposed solutions was conducted in July 2024, followed by a field trial from August to October 2024.

Table 5. 5W+1H on Lights Defect

| No | 5W + 1H | Number of Complaints |
|---|---|---|
| 1 | What | Address defects in aircraft lighting. |
| 2 | Why | Defects occur due to low-quality bulbs, unclear inspection SOPs, and untrained operators. |
| 3 | Who | The Maintenance Engineering team and operators responsible for light inspections. |
| 4 | When | Immediately, to prevent flight delays caused by lighting malfunctions. |
| 5 | Where | Aircraft lighting inspection areas in the hangar and on the apron. |
| 6 | How | The above problem can be solved by: |
| | | Provide retraining for operators on lighting inspection and maintenance standards. |
| | | Implement clearer and more structured SOPs for light inspections. |
| | | Replace the bulb supplier with one offering higher-quality products. |

Table 6. 5W+1H on Equipment/ Furnishing

| No | 5W + 1H | Number of Complaints |
|---|---|---|
| 1 | What | Reduce damage to cabin furniture. |
| 2 | Why | Damage occurs due to fragile materials, imprecise installation, and untrained operators. |
| 3 | Who | The Furnishings Maintenance team and inspection operators. |
| 4 | When | Before the next major inspection to prevent further damage. |
| 5 | Where | Aircraft cabin areas and maintenance hangars. |
| 6 | How | The above problem can be solved by: |
| | | Improve the quality of materials used for cabin furniture. |
| | | Provide specialized training for furniture installation and repair. |
| | | Implement scheduled inspections using high-precision installation tools. |

Table 7. 5W+1H on Navigation Defect

| No | 5W + 1H | Number of Complaints |
|---|---|---|
| 1 | What | Address issues with the navigation system |
| 2 | Why | Problems are caused by damaged sensors, inaccurate calibration tools, and incorrect data input. |
| 3 | Who | The Navigation team and operators responsible for calibration. |
| 4 | When | Within the next month to prevent navigation disruptions that could affect flight safety. |
| 5 | Where | Navigation control areas in the hangar and calibration stations. |
| 6 | How | The above problem can be solved by: |
| | | Replace damaged sensors and update the navigation module. |
| | | Conduct routine calibrations using more accurate equipment. |
| | | Provide additional training on correct data input and the importance of accuracy. |

Table 8. 5W+1H on Air Conditioning Defect

| No | 5W + 1H | Number of Complaints |
|---|---|---|
| 1 | What | Improve the reliability of the aircraft's air conditioning system. |
| 2 | Why | Issues arise from worn compressors, dirty filters, and operators who do not understand the system. |
| 3 | Who | The Air Conditioning Maintenance team and technical operators. |
| 4 | When | Immediately, especially during the summer when the air conditioning system is crucial. |
| 5 | Where | Maintenance hangars and air conditioning areas in the aircraft. |
| 6 | How | The above problem can be solved by: |
| | | Perform regular maintenance on compressors and clean filters frequently. |
| | | Replace old or worn components. |
| | | Provide in-depth training for operators on system maintenance and operation. |

Table 9. 5W+1H on Communications Defect

| No | 5W + 1H | Number of Complaints |
|---|---|---|
| 1 | What | Improve the reliability of the aircraft's communication system. |
| 2 | Why | Issues occur due to weak transmitters, damaged cables, and outdated communication SOPs. |
| 3 | Who | The Communications team and technical operators. |
| 4 | When | Within two weeks to ensure all aircraft maintain reliable communication. |
| 5 | Where | Communication control areas on the aircraft and in the maintenance hangar. |
| 6 | How | The above problem can be solved by: |
| | | Replace weak transmitters and repair damaged cables. |
| | | Update communication SOPs and ensure all staff follow the new procedures. |
| | | Conduct regular audits of the communication system to detect problems early. |

Table 10. 5W+1H on Autoflight Defect

| No | 5W + 1H | Number of Complaints |
|---|---|---|
| 1 | What | Enhance the performance of the autoflight system. |
| 2 | Why | Issues arise from worn servo motors, incompatible simulation tools, and unfocused operators. |
| 3 | Who | The Autoflight Engineering team and operators who manage the system. |
| 4 | When | Before the next flight to ensure the autoflight system operates optimally. |
| 5 | Where | Maintenance hangars and autoflight simulation rooms. |
| 6 | How | The above problem can be solved by: |
| | | Replace worn servo motors with new, more durable ones. |
| | | Update simulation tools to be compatible with the latest systems. |
| | | Provide training for operators to stay focused and understand the autoflight system better. |

Table 11. 5W+1H on Flight Controls Defect

| No | 5W + 1H | Number of Complaints |
|---|---|---|
| 1 | What | Improve the flight control system. |
| 2 | Why | Issues arise from loose hinges, worn control cables, and inattentive operators. |
| 3 | Who | The Flight Controls team and inspection operators. |
| 4 | When | Within three weeks to maintain stable flight control. |
| 5 | Where | Maintenance hangars and aircraft control areas. |
| 6 | How | The above problem can be solved by: |
| | | Tighten hinges and replace worn control cables. |
| | | Introduce stricter and more thorough inspections. |
| | | Replace theProvide specialized training to ensure operators understand the importance of accuracy in |

Table 12. 5W+1H on Indicating/Recording Systems Defect

| No | 5W + 1H | Number of Complaints |
|---|---|---|
| 1 | What | Improve the reliability of the indicating and recording systems. |
| 2 | Why | Issues occur due to unresponsive sensors, outdated calibration tools, and data input errors. |
| 3 | Who | The Indication team and technical operators. |
| 4 | When | Immediately to ensure all flight data is accurately recorded. |
| 5 | Where | Maintenance hangars and recording areas on the aircraft. |
| 6 | How | The above problem can be solved by: |
| | | Replace unresponsive sensors and update the recording devices. |
| | | Use new more precise calibration tools. |
| | | Provide training for operators to ensure data input accuracy. |

The results of this implementation showed a reduction in defects on seventy-three aircraft to a total of 400 occurrences.

The field data collected followed a log-normal distribution, as confirmed by the Goodness of Fit test presented in Figure 15.

After determining the type of data distribution, calculations were made to find the DPMO value using equations 1 and 2. The calculation process is as follows:

$$D_r = Q \,. D_o$$

$$D_r = 73 \,. 199 \;=14.527 \; defect\ opportunities$$

Based on the calculation of defect opportunities, there were 19,701 defect opportunities for 99 Boeing Series aircraft. This result was then used to calculate the Current DPMO using equation 2 as follows:

$$DPMO = \left(\frac{\Delta D}{D_r}\right) . 10^6$$

$$DPMO = \left(\frac{400}{14.527}\right) . 10^6 \; = \; 27.534{,}93$$

**Goodness-of-Fit**

| Distribution | Anderson-Darling (adj) | Correlation Coefficient |
|---|---|---|
| Weibull | 3,588 | 0,950 |
| Lognormal | 1,782 | 0,972 |
| Exponential | 12,114 | * |
| Loglogistic | 2,325 | 0,961 |
| 3-Parameter Weibull | 2,201 | 0,963 |
| 3-Parameter Lognormal | 1,808 | 0,972 |
| 2-Parameter Exponential | 5,859 | * |
| 3-Parameter Loglogistic | 2,294 | 0,961 |
| Smallest Extreme Value | 11,082 | 0,876 |
| Normal | 3,289 | 0,949 |
| Logistic | 3,813 | 0,937 |

Figure 15. Goodness of Fit Improvement Result

The calculation result indicates that the DPMO value after the improvement is 27,534.93, equivalent to a sigma level of 3.214. Figure 16 confirms the results of the improvement implementation over the period from August 2024 to October 2024. Based on this validation, the company plans to record the outcomes monthly and conduct evaluations every three months to ensure continuous improvement.

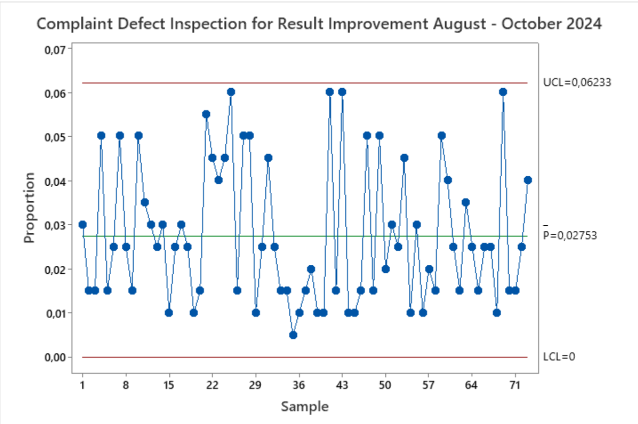



Figure 16. Control Chart Inspection Process August - October 2024

## Control.

The control process is carried out to maintain or improve the results achieved from the improvement activities. The control measures include:

***Check Sheet for the Training Provide to Engineer and Mechanic for One Periode***

This check sheet is used to monitor specific training activities conducted every four months over one week to ensure that engineers and mechanics maintain optimal performance (Table 13).

Table 13. Training Sheet

| Engineer/ Mechanic Sheet | | |
|---|---|---|
| Name | | |
| ID. | | |
| Month | Training Type | Sign |
| | | |
| | | |
| | | |
| | | |
| | | |

***Sigma Level Control Chart***

The Sigma Level Control Chart is created to monitor maintenance inspection activities on a monthly basis continuously. The purpose of this control chart is to track fluctuations in the sigma level each month, serving as an alert for management (Table 14).

Table 14. Sigma Level Control Sheet

| Sigma Level Control Sheet (Year) | | | | | |
|---|---|---|---|---|---|
| Month | Aircraft Qty | Opportunities | Defect | DPMO | Sigma Level |
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |
| 9 | | | | | |
| 10 | | | | | |
| 11 | | | | | |
| 12 | | | | | |

## Conclusions

The findings of this study demonstrate that the implementation of the Six Sigma method using the DMAIC approach and root cause analysis effectively reduced the defect rate in the inspection process for Boeing Series aircraft maintenance at a local airline in Indonesia. Before the improvements, the Defect Per Million Opportunities (DPMO) value was 104,309.43 with a sigma level of 2.796. Through various corrective measures, such as retraining engineers and mechanics, updating standard operating procedures (SOPs), replacing low-quality components, and utilizing more advanced inspection tools, the DPMO value was successfully reduced to 27,534.93, and the sigma level increased to 3.214. These implemented solutions not only significantly reduced defect frequency in inspection activities but also improved operational efficiency and reliability, helping the airline achieve its maintenance targets.

Recommendations for further development include regular evaluation and updates of maintenance processes and engineer/mechanic training to align with advancements in technology and safety regulations. Additionally, maintaining cross-functional collaboration and coordination involving maintenance, planning, and quality control divisions will ensure that improvements are sustainable and integrated into the aircraft maintenance management system.

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**Author Contributions**
For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "Conceptualization, Uti Roysen and Imbuh Rochmad; methodology, Rahmat.; software, Singgih Juniawan.; validation, Puty Lenggo Ginny, Singgih Juniawan. and Daruki.; formal analysis, Puty Lenggo Ginny; investigation, Singgih Juniawan.; resources, Uti Roysen; data curation, Daruki; writing—original draft preparation, Uti Roysen; writing—review and editing, Singgih Juniawan.; visualization, Daruki.; supervision, Imbuh Rochmad; project administration, Rahmat.; funding acquisition, Uti Roysen. All authors have read and agreed to the published version of the manuscript." Please turn to the CRediT taxonomy for the term explanation. Authorship must be limited to those who have contributed substantially to the work reported.

**Conflicts of Interest**
Declare conflicts of interest or state "The authors declare no conflict of interest." Authors must identify and declare any personal circumstances or interest that may be perceived as inappropriately influencing the representation or interpretation of reported research results. Any role of the funders in the design of the study; in the collection, analyses or interpretation of data; in the writing of the manuscript; or in the decision to publish the results must be declared in this section. If there is no role, please state "The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results".

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