

# Strategies for Reducing Defect Rates in Commercial Feed Production Using the RCA, FMEA, and 5W+1H Methods in the Feed Industry at PT XYZ

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## Abstract

The high level of defects in feed production, especially related to particle size (particle out of standard) is the main focus of this research because it has a significant impact on the quality of the final product and customer satisfaction. To overcome these problems, this research uses the Root Cause Analysis (RCA) method to identify the root causes of the problem, Failure Mode and Effect Analysis (FMEA) to determine risk priorities based on the Risk Priority Number (RPN) value, and the 5W+1H approach to provide implementable improvement proposals for the factors that cause defects. The results show that the dominant defect is caused by the clogged boiler duct factor with an RPN value of 200 which is the top priority in improvement efforts. The proposed improvement recommendations include conducting routine inspection and cleaning of boiler lines, as well as creating a checklist and cleaning schedule to ensure boiler lines remain clean and free from blockages. The implementation of this strategy is expected to reduce the level of defects so as to improve the efficiency of the production process and support the company's competitiveness in the animal feed industry.

**Keywords:** 5W+1H, FMEA, Quality Control, RCA

## 1. Introduction

The concept of quality is the extent to which a set of inherent characteristics can meet requirements, meaning that quality can be used with adjectives such as bad, good and excellent [1]. Quality is a concern in industry because improving product quality allows the industry to meet customer needs and expectations. Therefore, the products produced in this industry require quality control. Quality control is the management of products in order to meet the needs and desires of consumers. The main purpose of quality control is to obtain assurance that the quality of the products produced meets the specified quality standards.

PT XYZ is a company engaged in animal feed which has an important role in supporting the livestock industry, because the quality of feed has a direct impact on livestock productivity. The increasing demand for feed both in quantity and quality, encourages PT XYZ to produce high quality products consistently. However, there are still various problems in the feed manufacturing process that cause production errors, including moisture content not according to standards, high temperature, inappropriate particle size, uneven feed color, and contamination. These production defects not only affect the quality of the final product, but can also result in financial losses and damage to the company's reputation.

Reducing the severity of manufacturing defects requires a systematic approach to identify the root causes of problems and develop preventive measures. Root cause analysis (RCA), failed mode and effect analysis (FMEA), and the 5W+1H technique can be used as a framework to identify, analyze, and resolve various factors that cause errors during production. RCA is used to find the causes of a problem in detail, FMEA helps identify potential risks and their impacts, and 5W+1H creates a systematic action plan to reduce product defects. Therefore, by conducting this research, it is expected to identify the factors causing errors in feed production and devise appropriate strategies to minimize the defect rate, thereby improving product quality and increasing customer satisfaction.

## 2. Literature Review

### 2.1. Quality

Quality can be defined as the intrinsic and extrinsic characteristics of an item or result that render it suitable for the purpose for which it is intended. In essence, the quality of a product is contingent upon the specifications and design parameters established by the company, with the objective of aligning with the needs and expectations of consumers. Customer satisfaction represents a primary objective for the

production of specific goods or products. To enhance product quality, companies concentrate on elements that influence it, including performance, features, reliability, durability, and aesthetics. Furthermore, other crucial factors, such as the quality of raw materials and production processes, also significantly impact the ultimate quality of a product [2].

## 2.2 Quality Control

Quality control is an engineering and management activity which measures the quality characteristics of products or services, then compares the results of these measurements with the desired product specifications and takes appropriate improvement actions if differences in actual performance and standards are found. One approach that is often applied in the field is corrective action, which aims to address the causes of nonconformities or other undesirable conditions. Corrective actions are measures designed to eliminate the factors that cause nonconformities and ensure continuous quality improvement. In practice, corrective action often involves in-depth analysis of root causes, development of solutions and monitoring of implementation results. Quality control in the production process can be carried out in various ways, such as the use of high-quality raw materials, the application of adequate production machinery or equipment, the utilization of skilled labor, and the implementation of effective and efficient production processes [3].

## 2.3 Root Cause Analysis (RCA)

Root Cause Analysis (RCA) is a problem-solving process to investigate into a problem, concern or discrepancy that has been discovered. This process requires the investigator to identify the underlying causes of a situation, thus enabling appropriate treatment. In practice, RCA can involve evaluating processes, procedures, activities, behaviors, or conditions that contribute to the occurrence of problems [4]. RCA (Root Cause Analysis) is also defined as a system designed to maintain consistent quality of production results at minimal cost, while helping companies improve operational efficiency. This method is very useful for identifying the main causes of failures or problems that affect product quality, thus enabling strategic and sustainable improvements [5]

## 2.4 Failure Mode and Effect Analysis (FMEA)

The Failure Mode and Effect Analysis (FMEA) method is a risk management tool capable of identifying the likelihood of potential failures occurring and analyzing the causes and effects of failures, and eliminating or reducing the most relevant ones by proposing control measures. FMEA aims to address and minimize the risk of failure, focusing on high priority causes. This method is usually applied from the design stage to prevent potential failures early. Ideally, FMEA starts at the conceptual stage and continues throughout the product or service lifecycle. FMEA evaluates each risk and assigns a priority based on the Risk Priority Number (RPN). Through this approach, risks with the highest RPN value become the focus of improvement, making it easier to determine corrective measures. In addition, this method is able to prioritize improvements for each failure mode, providing clear guidance to improve product or service reliability [6].

Failure Mode and Effects Analysis (FMEA) is a structured method used to identify and prevent as many failures as possible (failure modes) of a system, design, process and/or service before a product or service is distributed and accepted by customers. This method was first introduced in the military by the US Armed Forces in the late 1940s. The main objective of FMEA is to identify the sources and root causes of quality problems in order to prevent errors or failures. In general, FMEA is designed to perform the most effective preventive measures in a process, so that failures can be avoided before the product or service is accepted by the customer. One of the important elements in FMEA is the Risk Priority Number (RPN), which is the product of three main factors: severity, frequency of occurrence, and detectability. In FMEA, each factor is usually rated using a scale of 1-10, so the maximum RPN value is 1000. Based on this RPN value, risks can be classified as low, medium, or high, which then becomes the basis for determining improvement priorities [7].

## 2.5 5W + 1H (What, Who, Where, When, Why, How)

The 5W+1H analysis method is a technique used to identify and address problems with a systematic approach through six basic questions: What (what should be done?), Why (why should it be done?), How (how should it be done?), Where (where should it be done?), When (when should it be done?), and Who (who is responsible?). This method is often used to dig up in-depth information, both in oral and written form. This method is widely utilized in various fields, such as journalism, management, and problem solving, to get a complete and in-depth picture of an issue. The technique is simple yet effective in supporting information gathering and the development of detailed solution strategies. In practice, the 5W+1H questions serve as a tool to obtain complete information on a topic. The following is an explanation of the six basic elements [8]:

- What: Focuses on identifying the main issue or topic being discussed.
- Where: Directs to the relevant location or scene.
- When: Refers to the time when the event took place or occurred.
- Why: Explores the reason or background of a problem or event.
- Who: Seeks information about the subjects, actors, or parties involved.
- How: Describes the process or steps that need to be taken to deal with the problem.

## 3. Research Method

This research was conducted at PT XYZ with a focus on minimizing the level of product defects, so as to improve product quality and customer satisfaction. Observations were made directly in the field through cooperation with the Quality Control (QC) section. The type of data used in this research is primary data obtained from PT XYZ as the object of research. The data consists of quantitative and qualitative data. Quantitative data is obtained from documents and archives managed by the QC section, while qualitative data is collected through interviews and direct observation at the company. The analysis method used in this research involves several approaches, namely Root Cause Analysis (RCA) to identify the main cause of the most dominant defect, Failure Mode and Effect

Analysis (FMEA) to analyze the impact of the failure of the defect by determining the Risk Priority Number (RPN) value, and 5W+1H to formulate a structured improvement proposal.

### 4. Result and Discussion

Based on the observation results, information on defects and the dominant types of defects in commercial feed from January 2024 - October 2024 are obtained as presented in table 1.

**Table 1:** Recapitulation of Commercial Feed Defects from January to October 2024

Month	Defect Type					Number of Defects
	Moisture Content Out of Standard	High Temperatures	Particle Size Out of Standard	Contamination	Non-homogeneous Color	
January	0	0	14	0	0	14
February	0	4	6	1	0	11
March	2	6	1	1	0	10
April	0	1	2	0	1	4
Mei	0	0	0	2	1	3
June	0	0	15	0	1	16
July	1	4	39	8	5	57
Agust	1	5	9	5	12	32
September	2	1	15	3	4	25
Oktober	0	7	6	1	2	16
<b>Total</b>	<b>6</b>	<b>28</b>	<b>107</b>	<b>21</b>	<b>26</b>	<b>188</b>

Table 1 shows the recapitulation of commercial feed defects from January to October 2024 with the types of defects of moisture content out of standard as many as 6, high temperature as many as 28, particle size out of standard according to 107, contamination as many as 21, and inhomogeneous color as many as 26.

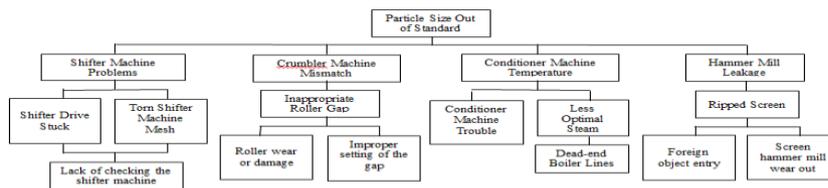
**Table 2:** Dominant types of defects in commercial feed from January to October 2024.

Jenis Kecacatan	Number of Defects	Percentages
Moisture Content Out of Standard	6	3,2
High Temperatures	28	14,9
Particle Size Out of Standard	107	56,9
Contamination	21	11,2
Non-homogeneous Color	26	13,8
<b>Total</b>	<b>188</b>	<b>100</b>

In table 2 it is known that the most dominant type of defect is particle out of standard, with a percentage reaching 56.9%. Therefore, appropriate and effective countermeasures are needed to reduce the number of defects and prevent the occurrence of particle out of standard defects which can cause various problems in animal feed production such as decreased product quality.

#### 4.1 Identification of Causes of Particle Out of Standard Defect Types Using Root Cause Analysis (RCA)

Sourced from the results of observations and interviews, the causes of this type of defect particle out of standard are several factors that can be seen in the following RCA diagram:



**Fig 1:** RCA Causes of Particle Size Out of Standard Defects

Based on Fig 1, it is known that the causes of particle size out of standard defects consist of 4 factors, namely hammer mill leakage, conditioner machine temperature, crumbler machine mismatch, and shifter machine problems. The hammer mill leakage factor is caused by a torn screen due to a worn hammer mill screen and foreign objects entering the hammer mill. The temperature factor of the conditioner machine is caused by the trouble conditioner machine and the steam is not optimal due to the dead-end boiler channel. In the crumbler machine inaccuracy factor is caused by the inappropriate setting of the gap between rollers caused by improper gap installation and worn or damaged crumbler rollers. The problematic shifter machine factor is caused by torn shifter machine mesh and jammed shifter machine drive, both problems are triggered by the lack of checking the shifter machine.

#### 4.2 Analisis Failure Effects of Out-of-Standard Particle Size Defect Types Using Failure Mode and Effect Analysis (FMEA)

FMEA (Failure Mode and Effects Analysis) is a method used to identify potential faults, their impact on product operations, as well as the steps that need to be taken to address the problem. In FMEA, the Risk Priority Number (RPN) calculation is used, where the higher the RPN value, the more important it is to take preventive action. RPN is calculated with the formula:

$$RPN = S \times O \times D$$

Information :

S : Severity

O : Occurate

D : Detection

Severity is the level of impact that can be caused if a failure occurs. The severity score is used to assess how serious the consequences of the failure are for the product, process, or system being analyzed. This score is usually given on a scale of 1 - 10, with 1 indicating a failure that has almost no impact, while 10 indicates a failure that can cause severe damage or even complete failure of the system or product.

**Table 3: Severity Table**

Rating	Kriteria
1	Negligible Severity. The consequences do not have a significant effect on the quality of the product so it is likely that consumers are not aware of the decline in quality.
2	Mild Severity. The consequences are minor so that they do not cause consumers to feel a decrease in product quality.
3	
4	
5	Moderate Severity. The consequences are not too severe but significant enough, consumers will feel a decrease in quality but are still within the tolerance limit.
6	
7	High Severity. The consequences have a high level of severity, where consumers will feel a decrease in quality that exceeds the tolerance limit.
8	
9	Potential Severity (very high impact). The consequences are very significant to the quality of the product and have a great potential to cause a critical decline in quality so that the product cannot be accepted by consumers.
10	

Occurrence refers to the likelihood of a failure or damage to the process or product. This factor measures how often a failure can occur, based on historical data, previous experience, or analysis. Occurrence is usually scored from 1 to 10, where 1 means very rare, and 10 means almost certain.

**Table 4: Occurrence Table**

Degree	By Frequency of Occurrence	Rating
Remote	1 time out of 300 days	1
	5 time out of 300 days	2
Low	10 time out of 300 days	3
	30 time out of 300 days	4
	45 time out of 300 days	5
Moderate	60 time out of 300 days	6
	75 time out of 300 days	7
	90 time out of 300 days	8
High	100 time out of 300 days	9
	> 120 time out of 300 days	10

Detection refers to the ability of a system or process to identify potential failures before they cause more serious effects. The detection score measures how effective a control measure or preventive measure is in detecting a failure before it occurs. Scores for detection are given in the range of 1 (very good detection) to 10 (very poor detection). The lower the detection score, the greater the likelihood of a failure going undetected, which increases the risk of damage or problems occurring.

**Table 5: Detection Table**

Rating	Criteria	By Frequency of Occurrence
1	Prevention methods are so effective that they eliminate the opportunity for the cause of failure to arise	1 time out of 300 days
2		5 time out of 300 days
3	Prevention methods are effective so that the probability of the cause of failure occurring is very small	10 time out of 300 days
4		30 time out of 300 days
5		45 time out of 300 days
6	Prevention methods sometimes trigger the problem because the probable cause is at a moderate level.	60 time out of 300 days
7		75 time out of 300 days
8	Prevention methods are less effective because there are enough possible causes that failures continue to occur repeatedly.	90 time out of 300 days
9		100 time out of 300 days
10	The prevention method is not effective so the possibility of failure causes is very large	> 120 time out of 300 days

Based on the results of the interviews, data were obtained regarding the severity, occurrence, and detection values as well as the control measures implemented to overcome the potential causes of defects. The next step is to calculate the RPN (Risk Priority Number) value.

**Table 6: Analysis of Defect Particle Size Out of Standard Using FMEA Method**

Failure Mode	Effects of potential failure	Severity (S)	Potential Causes of Failure	Occurrence (O)	Control Process	Detection (D)	Risk Priority Number (RPN)
Particle size out of standard	Decrease in product quality	10	Screen hammer mill wear out	4	Doing screen replacement	4	160
			Foreign object entry	3	Checking and repairing the hammer mill screen	3	90
			Dead-end boiler lines	4	Cleaning the boiler lines	5	200
			Conditioner machine trouble	3	Do repairs on damaged machine components	3	90
			Improper setting of the gap	4	Resetting the gap between rollers	2	80
			Roller wear or damage	3	Carry out compatible roller replacement	2	60

Lack of checking the shifter machine	4	Establish a schedule for periodic checks	4	160
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Based on Table 6, the analysis of defect particle size out of standard using the FMEA method, it is known that the highest RPN calculation results are obtained in the potential cause of failure of the dead-end boiler channel of 200, followed by the hammer mill screen factor wear and lack of checking the shifter machine of 160, the foreign object factor entering and the conditioner machine trouble of 90, the improper gap installation factor of 80, and the last roller factor is worn or damaged by 60. With this RPN value, the dead-end boiler channel factor is a priority for improvement.

### 4.3 Proposed Improvements Using 5W+1H

Based on the results of FMEA analysis, the largest RPN value is obtained, namely the dead-end boiler channel factor which is a priority for improvement. The proposed improvements will be analyzed using the 5W+1H method (what, why, who, where, when, how).

**Table 7:** Proposed Improvements for Defect Particle Size Out of Standard

Defect Type	Cause of Defect	What (what is the improvement plan?)	Why (why the need for improvement?)	Who (Who did the repair?)	Where (where is the repair location?)	When (when is the repair time?)	How (How the improvement steps?)
Particle size out of standard	Dead-end boiler lines	Perform an inspection, cleaning, and maintenance of the boiler lines.	To minimize the type of defect particle size out of standard in animal feed production so as to improve feed quality	Animal feed production operator	The production floor of the animal feed company	Before the animal feed production process	By conducting regular inspection and cleaning of boiler lines, as well as creating a checklist and cleaning schedule to ensure boiler lines are kept clean and free of blockages.

Based on the results of the 5W + 1H analysis, the proposed improvement is to inspect and clean the boiler line regularly, and make a checklist and cleaning schedule to ensure that the boiler line remains clean and free from blockages. This needs to be done to minimize particle out of standard defects in animal feed production so as to improve feed quality. This proposed improvement will be carried out by animal feed production operators on the production floor and will be carried out before the animal feed production process takes place.

## 5. Conclusion

Based on the recapitulation data of commercial feed defects for the period January-October 2024, several types of defects were found that can reduce the quality of animal feed such as moisture content out of standard, high temperature, particle size out of standard, inhomogeneous color, and contamination. The most dominant type of defect is particle out of standard with a percentage reaching 56.9% so further handling is needed. Root cause analysis using the RCA method identified four main factors, namely hammer mill leakage, conditioner machine temperature, crumbler machine mismatch, and shifter machine problems. The four main factors resulted in seven root factors that will be analyzed using FMEA, namely hammer mill screen wear, foreign objects entering, dead-end boiler channels, conditioner machine trouble, improper gap installation, worn or damaged rollers, and lack of checking the shifter machine. Furthermore, FMEA analysis which shows the highest RPN value is the dead-end boiler channel factor of 200 so that it is a priority for improvement. Based on the results of the 5W + 1H analysis, the proposed improvements made are to inspect and clean the boiler line regularly, as well as create a checklist and cleaning schedule to ensure that the boiler line remains clean and free from blockages. It is hoped that this improvement proposal can help reduce the type of particle size out of standard defect so that the quality of animal feed can be improved.

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