# Defect Analysis of ZA Fertilizer Products with Fault Tree Analysis (FTA) and Failure Mode Effect Analysis (FMEA) Methods at PT. XYZ

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## ARTICLE INFORMATION

## A B S T R A C T

PT XYZ is one of the fertilizer producers in Indonesia. The problem that often occurs in the company is that there are product defects that cause the production process to be ineffective. One of the products that has a high percentage of defects is non-subsidized ZA fertilizer. Research using Fault Tree Analysis (FTA) and Failure Mode and Effect Analysis (FMEA) methods to find out the causes of rejects or rejects in products and can provide preventive solutions so that these defects do not occur. In this study, 4 types of defects were found, namely failed weighing with a chance of defect occurrence of 0.138%, mixed color defect with a chance of defect occurrence of 0.115%, crystal clumping defect with a chance of defect occurrence of 0.115%, and defect mixed with dirt with a chance of defect occurrence of 0.116%, mixed color, crystal clumping, and mixed with dirt. The root causes of these defects include less careful operators, hasty operators, operators do not check the fertilizer bag machine needs maintenance, machine trouble, operators do not check the level on the machine regularly, poor air circulation, lack of cleaning facilities, operators work not according to SOP, lack of supervision, lazy operators, no barrier with other fertilizers, lack of lighting.

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## 1. INTRODUCTION

In this era, there are many companies, both companies in the service sector and the manufacturing sector. One of the goals for every company, especially industrial companies, is to improve service quality and product quality to satisfy customers. The company produces many products with various types, qualities, and shapes, all of which are intended to attract customer interest, so that consumers tend to buy these products. Therefore, every company is required to be able to create products with the best specifications so that customer satisfaction can be met. PT XYZ is one of the fertilizer manufacturers in Indonesia Among all products, ZA fertilizer is a non-subsidized product that has a high percentage of defects. ZA fertilizer is one of the non-subsidized fertilizer products from PT XYZ, also known as Ammonium Sulfate or

(NH4)2SO4. The problem faced by the company is that there are defective products that cause frequent customer complaints. In 2022, there were 24 customer complaints, of which 23 were related to the quality of non-subsidized ZA fertilizer products, namely crystal clumping (caking), non-uniform color, and failed weighing. Of the ZA products produced, in 2022 the percentage of defects reached 6%, which exceeded the company standard of 4% of total production.

In research in this company, researchers use the Fault Tree Analysis (FTA) method with recommendations for improving Failure Mode and Effect Analysis. According to Hidayat and Rochmoeljati (2020), in the research "Quality Improvement of Gandeng Fresh Bread Products with the Fault Tree Analysis (FTA) Method and Failure Mode And Effect Analysis (FMEA) at PT. XXZ" the FTA method is a systematic method of finding the root cause of problems. In addition, Fadli and Jufrizel (2020) in "Quality Control Analysis of Defective Overset Type Peci Products at PD. Divine Guidance Using the Fault Tree Analysis (FTA) Method and the Failure Mode And Effect Analysis (FMEA) Method". FMEA is useful for determining improvement priorities

## 2. LITERATURE REVIEW
### 2.1 Quality
According to Garvin (Supriyadi, 2021), Quality is a dynamic condition related to products, people/labor, processes and tasks, and the environment that meets or exceeds customer or consumer expectations. Consumer tastes or expectations of a product are always changing so product quality must also change or be adjusted. With changes in product quality, changes or improvements in labor skills, changes in production processes and tasks, and changes in the company environment are needed so that products can meet or exceed consumer expectations. According to quality experts such as Montgomery, DC (Ratnadi & Suprianto, 2020) Quality control is a process used to ensure the level of quality in products or services. Defining quality control is inseparable from what has been defined by defining that quality control is an engineering and management activity, with which we measure the quality characteristics of products, compare

them with specifications or requirements and take appropriate remedial action if there is a difference between the actual appearance and the standard (Supriyadi, 2021). Research by Mislan and Purba (2020), showed that the SQC method through the application of seven tools and utilization of FMEA to reduce the percentage of product defects.
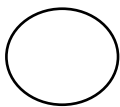
### 2.2 Fault Tree Analysis (FTA)
According to Hanif et al (2015), the FTA (Fault Tree Analysis) method is a technique used to identify risks that contribute to failure. This method is done with a top-down approach, which begins with the assumption of failure from the top event and then details the causes of a top event to a basic failure (root cause). A fault tree illustrates the state of system components (basic events) and the relationship between basic events and top events states the connection (Kartika, 2019).
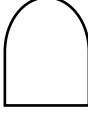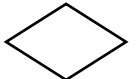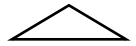
#### 2.2.1 Definition
Fault Tree Analysis (FTA) is a technique used in identifying risks that contribute to the occurrence of a failure identifying risks that play a role in the emergence of a failure, this method is carried out with a top-down approach, which begins with assumptions and assumptions. This method is carried out with a top-down approach, which begins with the assumption of failure from the top event and then details the causes of a top event failure of the top event and then detailing the causes of a top event to a basic failure (root event) event to a basic failure (root cause). Fault tree analysis identifies the relationship between causal factors and is displayed in the form of a fault tree. Fault tree analysis is one of the methods that can be used to analyze the root causes of work accidents or work failures. (Kartikasari, 2019)

#### 2.2.2 Symbols in Fault Tree Analysis

**Table 1.** Symbols in fault tree analysis

| Symbol | Term | Description |
|--------|------|-------------|
| ◯ | Basic Event | The basic event of an unexpected deviation from normal in a component of a system. |

| Symbol | Term | Description |
|---|---|---|
| | Top Event | Desired events at the top level that indicate failures that will be investigated further. |
| | Logic Event AND | Indicates the AND function, this function is used to indicate the output event will occur if all inputs occur |
| | Logic Event OR | Indicates the OR function, this function is used to show the output failure that occurs because there are one or more two failure events in the input |
| | Conditioning Event | A special condition that is applied to a logic gate when it meets a certain condition |
| | Undeveloped Event | Events that do not develop do not need to have a cause, as they are not sufficiently related. |
| | External event | Indicates events that are expected to occur and are not included in the failure event. |
| | Transferred Event | Continued description of a different event located on another page |

### 2.2.3 Fault Tree Analysis Procedure

Priyanta (2000) states that there are 4 stages to analyze with Fault Tree Analysis (FTA), namely:
1. Define and explain the problems and boundary conditions of the system under review.
2. Drawing a graphical model of the fault tree.
3. Finding the minimum cut set from the fault tree analysis.
4. Perform quantitative analysis of the fault tree (Priyanta, 2000).

### 2.2.4 Cut Set Method

The minimum cut set is the final equation that details the top-down. At this stage, the Fault Tree Analysis that has been formed will be converted into an equation with the following conditions:

- OR gate becomes a times sign (x)

- AND gate becomes a plus sign (+) (Parissing, 2020).

The four steps of forming a cut set based on Clemens' theory are as follows:
1. Discard all parts of the tree's constituent elements except the root or base.
2. starting directly below the peak event, install each gate and root cause.
3. Next, the main event is lowered down to create a matrix using numbers as well as alphabets. The alphabet will represent the main event gate and be the initial input to the matrix.
4. the result of the final matrix, yields only the numbers that represent the formers. each row of the matrix is a Boolean cut set. By inspection, it removes any row that contains all elements found in fewer rows. It then also removes redundant elements within the row and rows that copy other rows. The remaining rows are called the minimal cut set ( Clemens, 1993)

### 2.2.5 Cut Set Quantitative

To calculate the probability, only the sum of all successful processes and failed processes is required, this is shown in the following formula:

$$P_f = \left(\frac{F}{S+F}\right) \quad \text{.....................................(1)}$$

$$S = \left(\frac{S1+S2+\cdots+Sn}{n}\right) \quad \text{.......................(2)}$$

$$F = \left(\frac{F1+F2+\cdots+Fn}{n}\right) \quad \text{.......................(3)}$$

Description:
S = Number of Successful Products
F = Frequency of Occurrence
PF = Probability of Failure
PA = Probability A
PB = Probability B
Then proceed to calculate the probability in each gate, namely:
1. In the OR gate, the probability of each event or event is added and subtracted.
a. For 2 inputs, formulated:
PF =1-[(1- PA) (1-PB )]
$$PF = PA + PB - PA\ PB \quad \text{.................................(4)}$$
b. For 2 or more inputs, formulated:
$$PF = PA + PB - PA \quad \text{......................................(5)}$$
2. In the AND gate, the probability of each input is multiplied. Then at the AND gate at the number of inputs of 2 or more, calculate it in the same way, namely multiplied (Benedictus, 2021).

## 2.3 Failure Modes And Effect Analysis
### 2.3.1 Definition
According to John Moubrav, the definition of failure modes and effect analysis is a method used to identify the form of failure that may cause each failure and to ascertain the effect of failure associated with each form of failure (Taufik, 2021).

### 2.3.2 FMEA Steps
The eight steps of FMEA are as follows (Lestari, 2021): (1)Identify the course of the production process, (2) Identify potential failure modes of a production process, (3) Identify the potential impact of production failure, (4) Identify the causes of failure in the production process, (5) Identify detection modes in the production process, (6) Provide a rating assessment for Severity, Occurrence and detection values, (7) Calculation of RPN value by multiplying the value of Severity, Occurrence and detection, (8)Provide suggestions for improvements for failures that occur

### 2.3.3 Elements of FMEA
Elements of FMEA (Suliantoro, 2018): (a) Severity. Severity is an assessment of the seriousness of the effects caused. In the sense that every failure that arises will be assessed how serious it is. There is a direct relationship between effect and Severity, (b)Occurrence Rate. Occurance is the likelihood that the cause will occur and produce a form of failure during the lifetime of the product. Occurance is a rating value that is adjusted to the expected frequency and or cumulative number of failures that can occur, and (c) Detection. The detection value is associated with the current control.

$$RPN = S \times O \times D \dots\dots\dots\dots\dots\dots (5)$$

Where:
S = Severity
O = Occurrence
D = Detection

## 3. RESEARCH METHOD
The methods used in this research are the Fault Tree Analysis (FTA) and Failure Mode and Effect Analysis (FMEA) methods. This research begins with data collection by brainstorming and interviews to the company. Then the data obtained is entered into the quality control tool for further processing with the FTA method. After that, it is continued with the FMEA method to find which rejects must be resolved first. Next, formulate a research hierarchy structure and establish a pairwise comparison matrix.
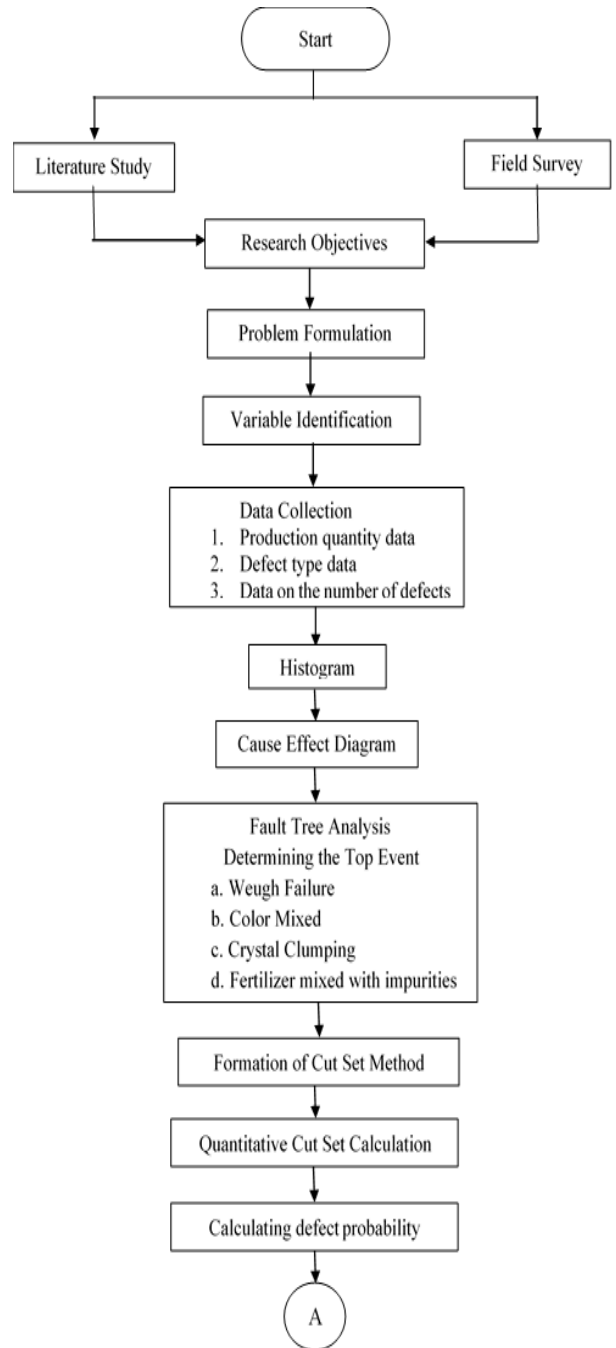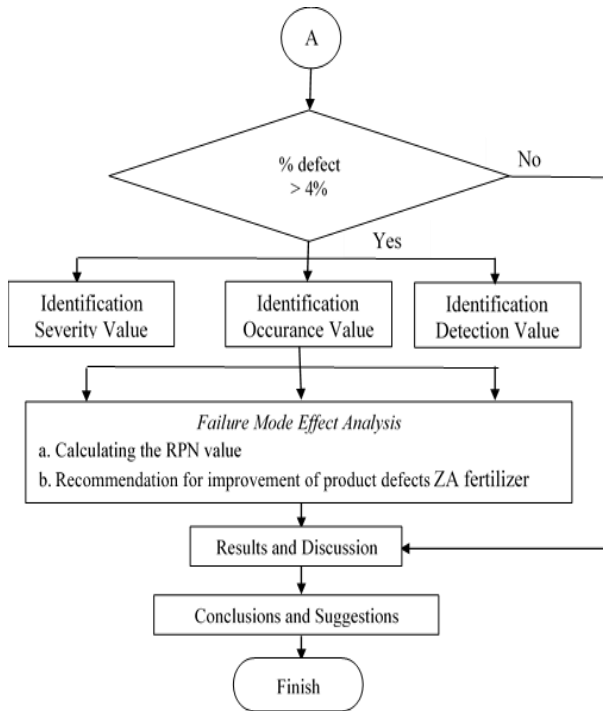
**Fig. 1.** Research stage

## 4. RESULT AND DISCUSSION

The data used in this study is data on the amount of production for 1 year from January to December 2022 with a total production of 139.719.5 tons. Several defects occur in ZA fertilizer products at PT XYZ. Product defect is an event where the product produced does not follow with predetermined standards so that it has no selling value. The following are the types of defects that often occur in ZA fertilizer products

1. weigh failure
   Overweight/underweight defects caused by problems with the bagging machine.
2. mixed colors
   Defects are caused by mixing fertilizer colors with other colors.
3. crystal clumping
   Defects are caused by operator negligence when checking the acidity level during the production process.
4. mixed impurities.
   Defects caused by impurities brought in during the storage process.

Then processed using Fault Tree Analysis and Failure Mode and Effect Analysis.

**Table 2.** Total production and number of defects data

| No | Month | Total Production (Per Ton) | Product defects (Per Ton) | Good Products (Per Ton) |
|----|-------|----------------------------|---------------------------|--------------------------|
| 1 | January | 11.037 | 219,35 | 10.817,65 |
| 2 | February | 7.360,5 | 147,25 | 7.213,25 |
| 3 | March | 9.535,50 | 121,65 | 9.413,85 |
| 4 | April | 10.323,00 | 126,25 | 10.196,75 |
| 5 | May | 6.970,50 | 68,45 | 6.902,05 |
| 6 | June | 18.741,00 | 95,15 | 18.645,85 |
| 7 | July | 11.610,00 | 74,95 | 11.535,05 |
| 8 | August | 6.469,50 | 13,15 | 6.456,35 |
| 9 | September | 321,00 | 95,25 | 225,75 |
| 10 | October | 20.767,50 | 80,35 | 20.687,15 |
| 11 | November | 14.220,00 | 113,5 | 14.106,5 |
| 12 | December | 22.364,00 | 75 | 22.289 |
| | **Total** | **139.719,5** | **1.230,3** | **138.489,2** |

(Source: production data PT. XYZ, 2023)
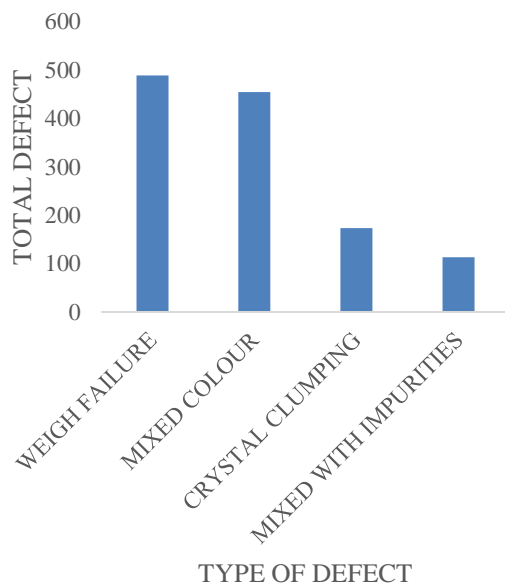
**4.1 Histogram**



**Fig. 2.** Histogram of product defect ZA Fertilizer Jan. – Dec. 2022

The following is a histogram of the comparison of the number of rejected products with the total production quantity. Based on the histogram figure, it can be seen that the order of each type of defect that occurs the most is known to be a failed weighing defect of 489 tons, a mixed color defect of 455 tons, a crystal clumping defect of 173.3 tons, and a defect mixed with dirt of 113 tons.

**4.2 Cause Effect Diagram**

The cause and effect diagram shows the cause of failure from the top event identified cause to the basic event.

**4.2.1 Cause Effect Diagram of Weigh Failure Defect**

Can be seen in the following figure which is a cause-and-effect diagram on the failed weighing defect.
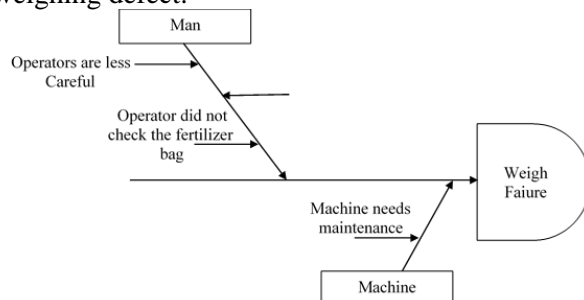


**Fig. 3.** Cause-effect diagram of weight failure

Causes of failure to weigh failure are human error, including excess & lack of product, operator is not careful, operator is in a hurry, operator does not check the fertilizer bag, machine trouble, machine needs maintenance.

**4.2.2 Cause Effect Diagram of Mixed Colour Defect**

Can be seen in the following figure which is a cause-and-effect diagram on the failed weighing defect.
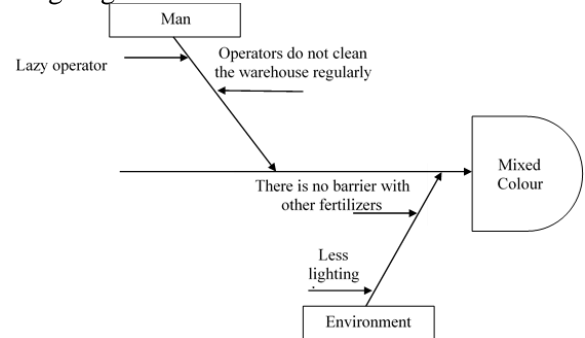


**Fig. 4.** Cause-effect diagram of mixed colour

Causes of Failure of mixed colors are dirty machines and dirty storage rooms, including lazy operators, operators do not clean the warehouse regularly, there is no barrier with other fertilizers, less lighting.

**4.2.3 Cause Effect Diagram of Crystal Clumping Defect**

Can be seen in the following figure which is a cause-and-effect diagram on the failed weighing defect.
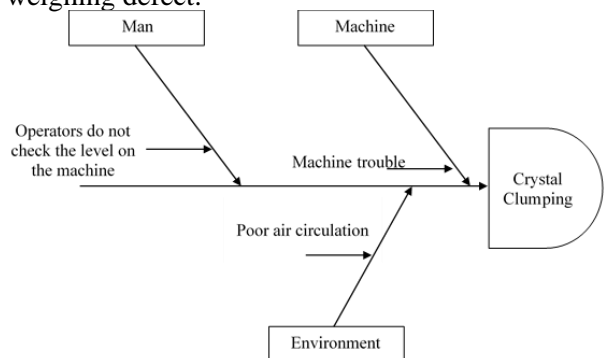


**Fig. 5.** Cause-effect diagram of crystal clumping

The causes of failure of crystal clumping defects are error level indicating machine and damp storage room, including operator fatigue, operator does not check the level on the machine regularly, level indicating machine

trouble, machine problems, and poor air circulation.

### 4.2.4 Cause Effect Diagram of Mixed with Impurities

Can be seen in the following figure which is a cause-and-effect diagram on the failed weighing defect.
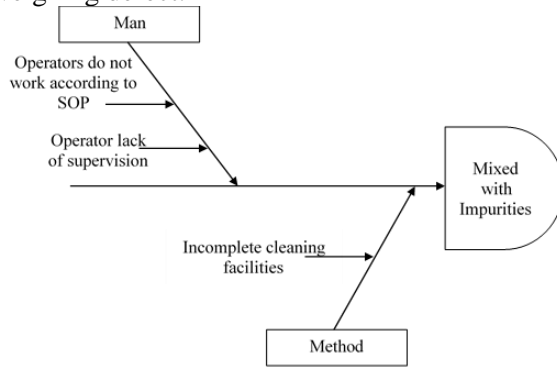


**Fig. 6.** Cause-effect diagram of mixed with impurities

The cause of the failure of defects mixed with impurities is a dirty storage room and mixed with impurities when heading to the warehouse, including incomplete cleaning facilities, operators working not according to sop, and lack of supervision.

### 4.3 Determination of Defect Structure (Cut Set Method)

The first analysis is to describe the causes of the defect in logical symbols.

### 4.3.1. Determination of Defect Structure for weigh failure defect

The results of the minimum cut set are depicted again in a simplified fault tree diagram called the equivalent fault tree, which can be seen in the following figure. This is to clearly know the evaluation results of the previous fault tree diagram. In the equivalent fault tree, root causes 1, 2 and 3 create an OR gate, while root cause 4 creates an AND gate.
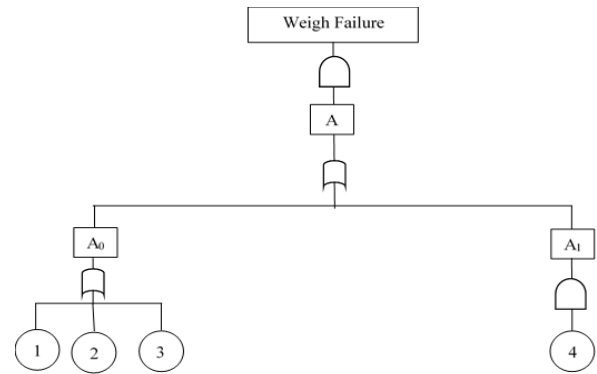


**Fig. 7.** Fault tree diagram of weight failure

Description:
A : Human error
$A_0$ : Product overweight & underweight
$A_1$ : Machine Trouble
1 : Operator is not careful
2 : Operator is in a hurry
3 : Operator does not check the fertilizer bag
4 : Machine needs maintenance

### 4.3.2. Determination of Defect Structure for mixed colors defect

The results of the minimum cut set are depicted again in a simplified fault tree diagram called the equivalent fault tree, which can be seen in the following figure. This is to clearly know the evaluation results of the previous fault tree diagram. In the equivalent fault tree, root cause 1 creates an AND gate, while root causes 2 and 3 create an OR gate.
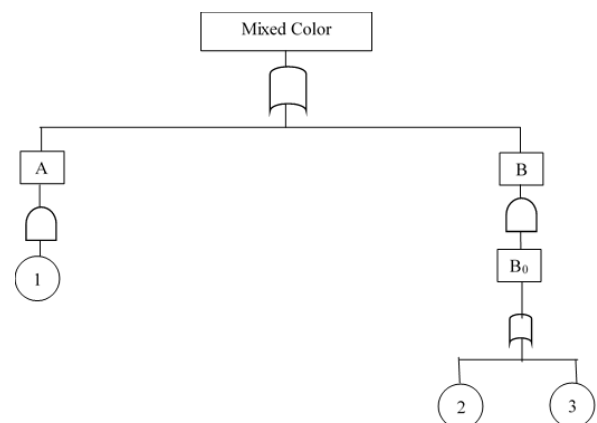


**Fig. 8.** Fault tree diagram of mixed color defect

Description:
A : Dirty machine
B : Dirty storage room
$B_0$ : Operator does not clean the warehouse regularly
1 : Operator is lazy

2 : There is no barrier with other fertilizers
3 : Less lighting

### 4.3.3. Determination of Defect Structure for crystal clumping defect

The results of the minimum cut set are depicted again in a simplified fault tree diagram called the equivalent fault tree, which can be seen in the following figure. This is to clearly know the evaluation results of the previous fault tree diagram. In the equivalent fault tree, root causes 1 and 2 create an OR gate, while root cause 3 creates an AND gate.
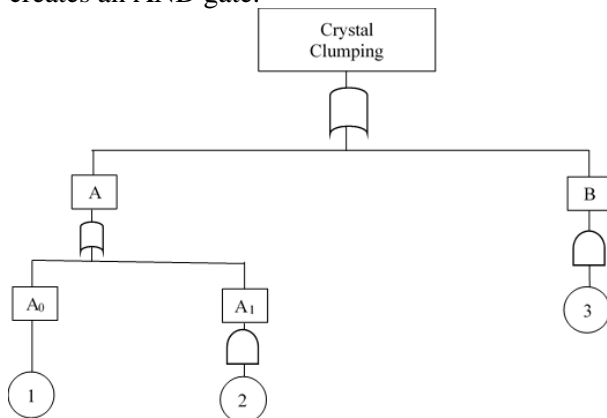


**Fig. 9.** Fault tree diagram of crystal clumping defect

Description:
A : The acidity level is not maintained
B : Damp storage room
$A_0$ : Operator fatigue
$A_1$ : Error level indicating machine
1 : Operator did not check the level on the machine
2 : Machine trouble
3 : Poor air circulation

### 4.3.4. Determination of Defect Structure for defects mixed with impurities

The results of the minimum cut set are depicted again in a simplified fault tree diagram called the equivalent fault tree, which can be seen in the following figure. This is to clearly identify the evaluation results of the previous fault tree diagram. In the equivalent fault tree, root cause 1 creates an AND gate, and root causes 2 and 3 create an OR gate.
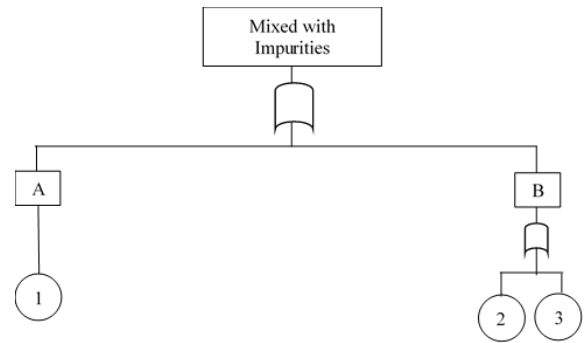


**Fig. 10.** Fault tree diagram of defect mixed with impurities

Description:
A : Dirty storage room
B : Mixed with dirt on the way to the warehouse
1 : Lack of cleaning facilities
2 : Operators work not according to SOP
3 : Lack of supervision

### 4.4 Probability calculation
### 4.4.1 Probability calculation for weigh failure defect

$P_1$ = 0,00039
$P_2$ = 0,00038
$P_3$ = 0,00038
$P_4$ = 0,00038
$P_{A0}$ = $P_1 + P_2 + P_3$
= 0,00039 + 0,00038 + 0,00038
= 0,0015
$P_{A1}$ = $P_4$
= 0,00038
$P_A$ = $(P_{A0} + P_{A1}) - (P_{A0} \times P_{A1})$
= ( 0,0015 + 0,00038 ) − ( 0,0015 x 0,00038)
= (0,001388− 0,00000057)
= 0,00138
$P_T = P_A$ = 0,00138= 0,138 %

### 4.4.2 Probability calculation for mixed colors defect

$P_1$ = 0,00038
$P_2$ = 0,00039
$P_3$ = 0,00039
$P_A$ = $P_1$
= 0,00038
$P_B$ = $P_2 + P_3$
= 0,00039 + 0,00039
= 0,00078
$P_{Mixed\ Color}$ = $(P_A + P_B) - (P_A \times P_B)$
= ( 0,00038 + 0,00078 ) − ( 0,00038 x 0,00078)
= (0,00116 − 0,0000003)

$= 0,00115$

$P_T = P_{Mixed\ Color} = 0,00115 = 0,115\ \%$

### 4.4.3 Probability calculation for crystal clumping defect

$P_1 = 0,00037$

$P_2 = 0,00039$

$P_3 = 0,0004$

$P_A = P_{A0} + P_{A1}$
   $= 0,00037 + 0,00039$
   $= 0,00076$

$P_B = P_3$
   $= 0,0004$

$P_{Crystal\ Clumping} = (P_A + P_B) - (P_A \times P_B)$
   $= (0,00076 + 0,0004) - (0,00076 \times 0,0004)$
   $= (0,00116 - 0,0000003)$
   $= 0,00115$

$P_T = P_{Crystal\ Clumping} = 0,00115 = 0,115\ \%$

### 4.4.3 Probability calculation for for defects mixed with impurities

$P_1 = 0,0004$

$P_2 = 0,00036$

$P_3 = 0,00041$

$P_A = P_1$
   $= 0,0004$

$P_B = P_2 + P_3$
   $= 0,00036 + 0,00041$
   $= 0,00077$

$P_{Mixed\ with\ Impurities} = (P_A + P_B) - (P_A \times P_B)$
   $= (0,0004 + 0,00077) - (0,0004 \times 0,00077)$
   $= (0,00117 - 0,00000031)$
   $= 0,00116$

$P_T = P_{Mixed\ with\ Impurities} = 0,00116 = 0,116\%$

Based on the data that has been processed, the probability of events with a minimal reject structure is obtained. Then each form of reject event will be identified with the following discussion:

### 1. weigh failure defect

Based on calculations using the Fault Tree Analysis method, the probability results calculated before evaluating are 0.00138 or 0.138% for 12 months of the production process. While the probability generated after doing the evaluation is 0.00153 or 0.153%.

### 2. mixed colors defect

Based on calculations using the Fault Tree Analysis method, the probability results calculated before evaluating are 0.00115 or 0.115% for 12 months of the production process. While the probability generated after doing the evaluation is 0.00116 or 0.116%.

### 3. crystal clumping defect

Based on calculations using the Fault Tree Analysis method, the probability results calculated before evaluating are 0.00115 or 0.115% for 12 months of the production process. While the probability generated after doing the evaluation is 0.00116 or 0.116%.

### 4. mixed with impurities defect

Based on calculations using the Fault Tree Analysis method, the probability results calculated before evaluating are 0.00116 or 0.116% for 12 months of the production process. While the probability generated after evaluating is 0.00117 or 0.117%.

### Failure Mode Effect Analysis (FMEA)

Failure Mode and Effect Analysis is a reliability analysis method intended to identify failures, which have the consequence of affecting the functioning of the system within the boundaries of a given application, thus allowing priorities for action to be. Traditionally, FMEA is used to conduct risk analysis through the Risk Priority Number (RPN), which is derived from a combination of Occurrence (O), Severity (S) and Detection (D) (Aprianto et al., 2021

**Table 3.** FMEA analysis

| No. | (Failure Modes) | (Failure Effect) | SEV | POTENTIAL CAUSES | OCC | CONTROL | DET | RPN | Ranking |
|-----|-----------------|------------------|-----|------------------|-----|---------|-----|-----|---------|
| 1. | Weigh Failure | Reject failures in the form of overweighing will result in company losses, while underweighing impacts consumer confidence. | 8 | • operator is not careful<br>• operator is in a hurry<br>• operator did not check the fertilizer bag<br>• machine needs maintenance. | 7 | • Given a warning<br>• Check by operator | 4 | 224 | 1 |

| No. | | Effect | Cause | | | Recommendation | | RPN | Rank |
|---|---|---|---|---|---|---|---|---|---|
| 2. | Crystal Clumpig | Rejects of crystal clumping cause uneven distribution of fertilizer, reducing the quality of fertilizer absorption. | • Machine trouble<br>• operator does not check the level on the machine regularly<br>• poor air circulation. | 5 | 7 | • Given a warning<br>• Machine check by operator<br>• Addition of air ventilation | 6 | 175 | 2 |
| 3. | Mixed with Impurities | Rejects mixed with impurities cause unmarketable products that cause company losses. | • lack of cleaning facilities<br>• operators do not work according to SOP<br>• lack of supervision. | 7 | 5 | • Addition of cleaning facilities<br>• Given a warning<br>• Tightened supervision | 3 | 105 | 3 |
| 4. | Mixed Color | Mixed color rejects lead to mixed differentiation between subsidized and non-subsidized fertilizers. | • lazy operators<br>• no barrier with other fertilizers<br>• lack of lighting. | 4 | 4 | • Warning given<br>• Addition of dividers<br>• Addition of warehouse lighting | 5 | 80 | 4 |

(Source: result focus group discussion with experts, 2023)

From the results of the analysis using the FMEA method, it was found that the defect failure to weigh with the highest RPN value of 224. The defect failed to weigh in the form of less weighing will cause a decrease in customer confidence. While over weighing will cause losses for the company. This defect is caused by product overload and shortage, and machine trouble. The excess and shortage of products is caused by less careful operators, hasty operators, and operators not checking the fertilizer bag. What causes machine trouble is that the machine needs maintenance. Recommendations for improvements that can be made are increasing operator rest hours so that they are not bored at work. There can be a rolling system if there is a lot of work, requiring operators to check every bag of fertilizer and perform regular machine maintenance.

Then followed by the crystal clumping defect with an RPN value of 175. The crystal clumping defect causes uneven distribution of fertilizer, reducing the quality of fertilizer absorption. This defect is caused by the acidity level is not maintained, and the storage room is damp. The acidity level is not maintained due to operator fatigue and level indicator machine trouble. Operator fatigue is caused by operator negligence, and the operator does not check the level on the machine regularly. Meanwhile, the level indicator machine is in trouble because the machine needs maintenance. The damp storage room is due to poor air circulation. Recommendations for

improvements that can be made are to carry out maintenance on machines that are not working properly, require operators to routinely check the level on the machine periodically, and make sure that the machines are in good condition. Check the level on the machine regularly, and add air ventilation in the fertilizer storage room. Then followed by mixed dirt with an RPN value of 105. defects mixed with dirt cause unmarketable products that cause company losses. defects mixed with dirt are caused by dirty storage rooms and mixed with dirt when heading to the warehouse. The dirty storage room is due to lack of cleaning facilities, less careful operators, and lazy operators. While mixed dirt on the way to the warehouse is due to operators working not according to SOP, and lack of supervision. Recommendations for improvements that can be made are requiring operators to clean their bodies before working. This is supported by the addition of cleaning facilities around the production site, and added cleaning infrastructure, according to the needs of the factory.

Next is the mixed color defect with an RPN value of 80. The mixed color defect causes the mixing of the difference between subsidized and non-subsidized fertilizers. The mixed color defect is caused by dirty machines and dirty storage rooms. Dirty machines are caused by less careful operators. While the dirty storage room is caused by operators not cleaning the warehouse regularly. This is because operators are lazy, there is no barrier

with other types of fertilizers, and the lighting is lacking. Recommendations for improvements that can be made are giving rewards to operators who can meet targets without making mistakes, adding dividers for different types of fertilizers, and adding lighting, especially in the storage room.

## 5. CONCLUSION

Based on the research conducted, there are 4 types of defects at PT XYZ, namely defects that fail to weigh with a probability of 0.138%, color defects mixed with a probability of 0.115%, crystal clumping defects with a probability of 0.115%, and defects mixed with impurities with a probability of 0.116%. From the four defects above, we get several root causes that cause these defects to occur with the highest probability of occurrence, namely, lack of supervision with a probability value of 0.00041, operators not working according to SOP with a probability value of 0.0004, and less air circulation with a probability value of 0.0004. From the results of analysis and calculation using the FMEA method, the calculation results for three types of defects with the largest RPN value are obtained, namely, the first type of defect failed to weigh with an RPN value of 224, the second type of crystal clumping defect with an RPN value of 175, and the third type of defect mixed with dirt with an RPN value of 105.

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