

Analysis of Product Defects in the Packing Production Process at PT.XYZ Using FTA and FMEA Methods

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ABSTRACT

A product defect is a product failure that does not meet the quality and standards that have been determined from a product. Product defects occur because of a problem in the production process. With a product defect in the coffee packing production process at PT. XYZ, one of which is unstable weight and the exp date is not printed, so the researcher analyzes the problem with one of the six sigma methods, namely using the FTA and FMEA methods. Failure Tree Analysis (FTA) is a graphical model containing the various parallels and various sample errors that lead to the occurrence of an undesired event. Meanwhile, Failure Mode and Effect Analysis (FMEA) is a structured procedure to identify and prevent possible failure modes. In this study, four types of defects occur in the packaging process including folded packaging, top leaking packaging, bottom leaking packaging, blurry exp date.

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1. Introduction

In the current industrial era 4.0, there are still many companies that can be said to be less competent in terms of the quality of making products for consumers. This has a considerable impact on consumers, because if the products purchased by consumers are not satisfactory, then consumers will switch to other similar products. To maintain the existence and develop a business that is currently experiencing increasingly fierce competition, every company must pay attention to the quality of the products it produces. Because in addition to the number of outputs from many companies, it must be accompanied by good product quality and by consumer expectations.

The influence of unqualified or defective products in a company has an impact on quality costs, company image, and customer satisfaction. The more products that fail or are defective, the greater the production costs incurred by the company. Various kinds of actions will appear if there are many failed or defective products such as inspections, rework, and so on. Likewise, the profits obtained by the company will be slightly according to the consequences of these events. According to Mulyadi (1999), defective products are products that do not meet predetermined quality standards but require rework costs to repair them. These products can be economically refined into even better products. There are two classifications of defective products, namely major and minor defects. Major defects are the level of defects that greatly affect the decline in product quality. If improvements are made, it will

not completely become a product of good quality. Meanwhile, minor defects are minor defects in a product, if repairs are made, it will not have a major effect on the resulting product.

Based on quantitative data obtained from the results of each production, product defects often occur in the coffee production process at PT. XYZ which causes reduced profits for the company, there are product defects such as unstable weight, folded packaging, and the writing of EXP Date is not printed, so the researcher raised this problem as a topic to find a solution for. Researchers use the FTA and FMEA methods to find out the causes of product defects and reduce product defects in production.

One of the methods used for quality control is Fault Tree Analysis (FTA) and Failure Mode and Effect Analysis (FMEA). FTA is a method that can analyze system failures. FTA can also look for aspects of the system involved in the failure and find the causes of product defects in the production process. While FMEA is a method needed to define, identify, and eliminate problems in the production process.

2. Literature Review

a. Quality

According to Gunawan (2016) quality is everything that satisfies the customer or is by the requirements and needs of the customer so quality is an important factor for consumers in determining their choice of a particular product or service. The word quality has a very broad and different meaning so the meaning of the word quality has a different context when it reaches consumers. According to Napitupulu (2018), the notion of quality is also put forward by experts from the producer's point of view. The definition of quality (quality) as explained by the American Society for Quality is "all the features and characteristics of a product or service that can satisfy a visible or vague need" according to (Heizer (2009), Supriyadi (2018)). According to Devani (2016), the quality of goods or services can be related to reliability, durability, timing, appearance, integrity, purity, individuality, or a combination of these factors. The quality of a product is considered as something that must always be controlled and inspected to meet consumer needs (Weckenmann (2015), Puspitasari, et al 2017).

Although there is no universally accepted understanding of quality, from several definitions there are some similarities in quality elements, namely an effort to manufacture a product that meets or exceeds consumer desires. Based on these elements, Goetsch (1994) created a definition of quality, which is a dynamic condition associated with products, services, people, processes, and the environment that meet or exceed expectations.

b. Quality Control

According to Arini (2004), quality control is a system of verification and maintenance of the desired level of product or process quality using careful planning, use of appropriate equipment, continuous inspection, and corrective action if necessary. Thus the results obtained from this quality control activity can meet the standards that have been planned to be set.

According to Harahap, et al (2018) Quality control is a technique and planned action activity carried out to achieve, maintain and improve the quality of a product and service so that it conforms to predetermined standards and can meet consumer satisfaction. According to Besterfield (2006), Nasution (2018) good quality control needs to be implemented, using quality improvement methods or activities that aim to reduce the percentage of defective products so that the products produced have good quality so that profits and customer satisfaction can be achieved. According to Ratri, et al (2018) Quality control and improvement activities are not only carried out once or twice when problems occur but must be carried out continuously by the company to maintain and maintain product quality

so that it is always good as well as evaluated material and decision-makers and actions. that needs to be done related to product quality control.

c. Defective Products

According to Hansen and Mowen (2001), defective products are products that do not meet their specifications. This can be interpreted not by the quality standards that have been determined. Defective products that occur during the production process refer to products that cannot be accepted by consumers. Defective products are products that do not meet the quality standards that have been set but have to pay for rework to repair them. These products can be economically refined into even better products (Mulyadi, 1999).

The product is said to be defective if the product is not safe in use, does not meet the requirements that have been set as desired by consumers by considering various conditions, especially about product packaging, the function that should be desired from the product, and when the product is marketed. Products that do not have defects when marketed can be accepted by consumers.

d. Fault Tree Analysis (FTA)

Method Quoted from Purnomo (2007), Fault Tree Analysis is a fault tree analysis that can be described as an analytical technique. A fault tree is a graphical model containing various parallels and various sample errors that cause the occurrence of an undesired event. The fault tree is obtained by interviewing management or carrying out direct observations of the production process that occurs in the field, then the data obtained is assembled in the form of a fault tree model.

The fault Tree Analysis method serves to identify the failure (failure) of a system. Fault Tree Analysis is function-oriented or better known as the “top-down approach” because this analysis starts from the top-level system and continues downwards (Priyanta (2000), Utama, et al, (2016)). This method is carried out with a top-down approach, starting with the assumption of failure from the peak event and then detailing the causes of a basic failure (Hanif et al, 2015).

e. Failure Mode and Effect Analysis (FMEA) Method

According to Chrysler (1995), Failure Mode and Effect Analysis (FMEA) is a structured procedure to identify and prevent as many failure modes as possible. FMEA is used to identify the sources and root causes of a quality problem. Failure Mode And Effect Analysis (FMEA) is a structured procedure to identify and prevent possible failure modes. A failure mode of any kind includes a defect, a condition outside the specified specifications, or a change in the product that causes the product to malfunction ((Gasperz, 2002), Muttaqin (2017)). FMEA is a technique used to define, identify, and eliminate failures and problems in the production process, then weigh and sort based on the Risk Priority Number (RPN) (Supono, 2018).

In FMEA design, observations are focused on product design. While the FMEA process, observations are focused on production process activities (Puspitasari, 2014). FMEA is used to analyze and provide rating values for frequent failures (Salomon et al, (2015), Suryaningrat et al, (2019)) and Failure mode and effect analysis (FMEA) is used in engineering design, such as designing, identifying, and elimination of system failures, both those that have occurred and those that are potential (Darmawan et al, 2016).

The Failure Mode and Effect Analysis (FMEA) steps are to identify the existing potentials, namely: potential failure, potential effects of failure mode, potential causes of failure mode, and evaluation of existing controls or design verification (Risyadi et al, 2018).

The purpose of the FMEA is to identify and assess the risks associated with potential failures. The FMEA method is used to identify all activities that are at risk of causing accidents and analyze their severity (Suryani, 2018). Each failure mode has potential causes and effects arising from the

failure (Kartika et al, 2016). FMEA does not consider human error and the focus of the study is on the system components not on the system relationships that often cause failure (Apriani et al, 2016).

f. Pareto chart

According to Pyzdek (2002) Pareto analysis is a process of alerting opportunities to determine which of the many potential opportunities should be pursued first. Pareto analysis should be used at various stages in a quality improvement program to determine which steps to take next.

The Pareto diagram is a diagram developed by an Italian economist named Vilfredo Pareto in the 19th century (1993). Pareto diagrams are used to compare various categories of events arranged according to size, from the largest on the left to the smallest on the right. This arrangement will help us to determine the importance or priority of the categories of events or causes of the studied events or to identify the main problems in the process. With the help of Pareto diagrams, activities will be more effective by focusing on the causes that have the greatest impact on events rather than reviewing various causes at one time (Nasution, 2005). The benefit of the Pareto diagram is to find or know the main priorities of the problems at hand and are the key in solving the problems at hand and comparing them to the whole.

3. Reseach Method

In solving the problem in this research, steps are needed to describe the approach and model of the problem. The following are the steps taken in this research:

a. Field Survey

The field survey is the first step in conducting research. At this stage, observations were made on the coffee production process from raw coffee to ground coffee that was ready to be marketed.

b. Literature Study

A literature study was conducted to obtain concepts and methods related to the problem and research objectives to be achieved. Field Surveys run simultaneously with literature studies in solving the problems to be studied.

c. Problem Formulation

Formulation of the problem, namely the stages to formulate a problem, problem boundaries, and research objectives to be studied.

d. Data Collection

At this stage, the necessary data collection is carried out as data that will be used to solve the problems that have been formulated.

e. Data Processing

At this stage, data processing is carried out based on the problems to be discussed. Data processing in this study is a process of combining the Fault Tree Analysis (FTA) and Failure Mode and Effect Analysis (FMEA) methods. The steps taken in the FTA method are identifying problems from the packaging process for coffee production, making a table that classifies the process of production activities and the number of defective products. After defining the problems that cause product failure, then make a Fault Tree, which is a simple analysis that can be described as an analytical technique.

While in the FMEA method, measurements are made of all processes of coffee packing production activities. The stages of the work carried out are identifying packing production failures, identifying causes of production process failures, determining severity, occurrence, detection, and RPN values in the packing production process. The last step is to do data analysis.

f. Proposed Improvements

g. Conclusion and Suggestions

At this stage, conclusions are drawn from the research that has been carried out, as well as suggestions for further research related to this research, as well as interested parties in efforts to reduce the level of product defects in the process of production activities.

4. Results and Discussion

In the Coffee Production Process at PT. XYZ there are 5 stages, namely: Sorting coffee beans, roasting coffee beans, grinding coffee beans, packing coffee powder, storage to the finished goods warehouse. The first step is sorting the coffee beans, which is sorting the good coffee beans, separating the gravel and plastic fibers from the sacks, and sorting the coffee beans whether there are crushed or not. If any coffee beans are destroyed, they will be sent to the return warehouse to be returned to the supplier.

The second step is roasting the coffee beans. Coffee beans are fried at a temperature of 220°C - 225°C. After frying the coffee beans, the third step is the beans are transferred to a grinding machine to grind the coffee beans. After the coffee beans have been ground and become coffee grounds, then a cup test is carried out, to determine whether the taste of the coffee powder is up to standard or not. After the test is ok, the coffee grounds are transferred to the coffee powder shelter in the coffee packing machine. After the shelter is full, the fifth step is to run the coffee packing machine. Before running the coffee machine, the operator checks the packing machine first, especially on the machine distance and the N2 level in the machine. N2 or nitrogen is used to maintain the aroma of coffee when it is in the packaging.

Next, the operator must verify several 1 boxes to the QC. Furthermore, QC will check the weight of the sachet which has a standard of 383 gr – 398 gr. After the weight of the sachet is in the range, a visual check of the coffee packaging is carried out, starting from the precise shape, the folded packaging, the vertical and horizontal seals, and checking the exp date. After everything is ok, a leak test is carried out to determine the strength of the vertical and horizontal sealing. After no leakage was found, the N2 in the packaging was checked which was 3%. After checking that N2 is ok, the packing machine is ready to operate and QC also checks every 1 hour.

After checking QC, the packaging is put into the box that has been provided, then the box is placed on the conveyor, to carry out the isolation process and check the weight of the box, if the weight of the box is not up to standard, the machine will reject it and the box must be rechecked its contents. If the weight of the box is ok and the weight is according to the standard, then the box is placed in the finished goods warehouse for storage.

During November 2020 PT.XYZ produced 558,831 ground coffee with 7,167 defects, therefore, researchers analyzed the causes of various product defects. Based on the data that has been collected, it will be processed using the FTA method first to determine the solution to the problem taken, namely the factors that cause disability and the level of disability that occurs in each event that occurs. The types of disability in this study can be seen in Table 1 below.

Table 1. Types of Product Defects

No	Type of Defect	Number of Defects	Disability Percentage	Percentage of Cumulative Disability (%)
1	Folded Packaging	213	52%	52%
2	Top Leaky Packaging	78	19%	71%
3	Bottom Leaky Packaging	68	16%	87%
4	Blurry Expiration Date	54	13%	100%

After knowing the percentage of defects, the Pareto diagram is determined. The Pareto chart is the process of alerting opportunities to determine which of the many potential opportunities should be pursued first. A Pareto chart based on data on the type of disability can be seen in Figure 1. below.

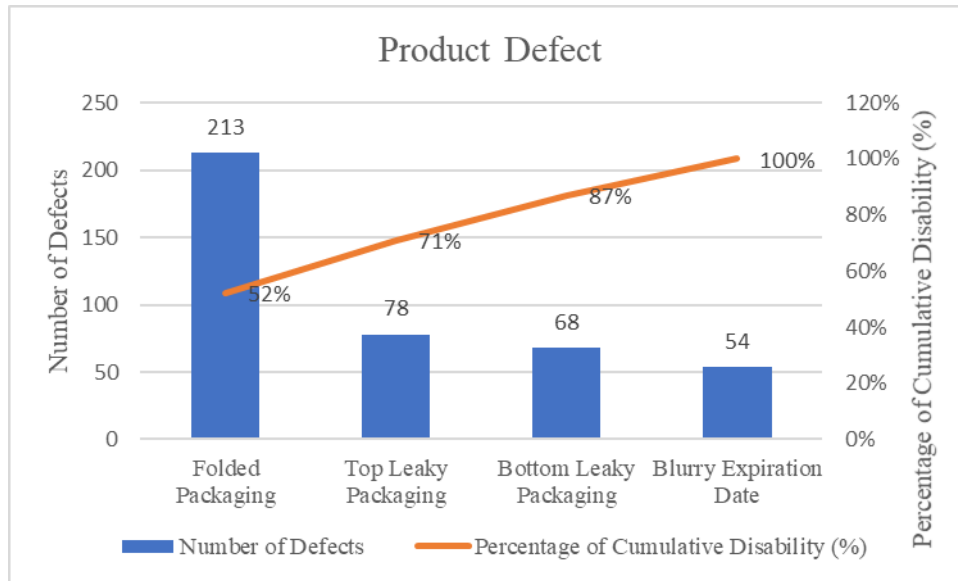


Figure 1. Pareto Diagram of Defective Products

After knowing the number of product defects and the Pareto diagram, an FTA will be carried out based on the type of defect. In the image below, you can see the FTA based on the defects of the folded packaging.

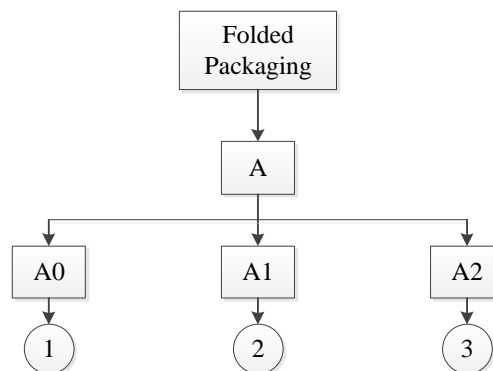


Figure 2. Folded Packaging FTA

Information:

- A : Folds at the top and bottom of the packaging
- A0 : Human
- A1 : Machine
- A2 : Material
- 1 : Operators Are Not Accurate
- 2 : The chopsticks on the machine are not precise
- 3 : Corrugated plastic

Based on the collected FTA data, it will be processed using the FMEA method. The FMEA method is a structured procedure to identify and prevent possible failure modes. FMEA method consists of determining the severity value, occurrence value, detection value. Severity value is the first

step to analyze risk which calculates the amount of impact or intensity of events that affect the final result of the process. The impact is given a score starting from a scale of 1 to 10.

The second step is to determine the Occurance Value. The occurrence value is a prediction that the cause of failure will occur and produce a form of failure during product production. After determining the severity value and occurrence value, the third step is to determine the detection value. Detection value is an effort to prevent the production process and reduce the failure rate in the production process. After determining the severity value, occurrence value, and detection value, the next step is to determine the RPN value. The RPN (Risk Priority Number) value determines the highest value of the failure mode. The RPN value is obtained from the following formula:

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

Information:

S : Severity Value

O : Occurrence Value

D : Detection Value

The following in Table 2. is the RPN value of each failure mode as follows:

Table 2. RPN Value

No	Process Description	Type of Disability	Severity Value	Occurrence Value	Detection Value	RPN Value
1	Exp Date Printing	Exp Date Blur	6	2	1	12
2	Packaging Formation	Folded packaging Uneven plastic	4 4	5 2	6 1	120 8
3	Sealing over horizontal packing	Dirty top <i>Jauw</i> Top leaking packaging	3 4	7 2	2 3	42 24
4	Sealing bottom horizontal packing	dirty bottom <i>Jauw</i> Bottom leaking packaging	3 4	8 2	2 4	48 32

5. Conclusion

Based on Table 2. the first order is the highest RPN value for the type of folded packaging failure, which is 120. Next, the bottom-down failure mode is dirty with an RPN value of 48. The third order is the top-gross failure mode with an RPN value of 42. The fourth sequence is the failure mode of leaky packaging. below the RPN value of 32. Next in fifth place is the top leaking packaging failure mode with an RPN value of 24. In the sixth order, namely the opaque Exp date failure mode with an RPN value of 12. And in seventh place with the lowest RPN value, namely the plastic failure mode with uneven values. The RPN is 8.

Recommendations in this study, in reducing the level of product defects at PT. XYZ is to install a sensor on the ribbon line on the packing machine, the operator checks the chopsticks on the machine once a week, checks the roll before using it, and brushes thoroughly before running the machine.

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