

## APPLICATION OF THE FMEA METHOD IN DETERMINING IMPROVEMENT PRIORITIES IN THE PRODUCT QUALITY SYSTEM AT COMPANY X

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### Abstract

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Company X is a manufacturing company integrated with production segments ranging from spinning, weaving, dyeing, and finishing. The company has contributed to advancing the Indonesian textile industry as an important element in the domestic production sector. However, during the production process defects often occur or the results of goods that are not in accordance with company standards often occur. The purpose of this research is to identify the causes of defects, as well as to form priority recommendations for improvement with the aim of maintaining product quality according to company standards. Data analysis applied in this study uses the Failure Modes Effect Analysis (FMEA) method. The results of this study indicate that there are 7 types of defects with the highest frequency, namely colour spots/chemical defects which are the priority for improvement in the quality system. There are 9 failure modes with the highest RPN, namely 360 in the imperfect Drug Dissolution Failure Mode. There are 5 factors that cause defects and suggestions for improvements to each problem in these factors.

Keywords: Prioritization of Improvement, Quality System, Company Products

### 1. INTRODUCTION

The tight competition in the industrial world today has required every company to provide the best quality of their products in order to remain competitive in the global market. Maintaining product quality is the most important aspect of producing an item or product. By maintaining the standards and quality of a product, the company will be able to run its business well and be able to provide satisfaction to its customers. The level of customer/consumer satisfaction is an important indicator that can be used as a reference for companies in meeting consumer needs. The company must always be able to maintain the quality of its best products so that it can show the integrity of the company in providing the best products so that product demand in the market can increase and can achieve maximum profit.

Quality is compliance with the needs that include availability, delivery, reliability, maintainability and cost-effectiveness (Crosby, 1979). Efforts to maintain product quality can be successful if a company can carry out production by fulfilling the aspects of availability, delivery, reliability, maintainability and cost-effectiveness.

Company X is a textile company that produces polyester fabric and cotton fabric. The company is always committed to maintaining product quality in order to satisfy its customers. Defects in a product can significantly affect customer satisfaction so maintaining product quality is the most important aspect that company X wants to maintain. but in the production process there are still frequent defects. based on the recap of the data collected there are several types of defects in company X's products. the following is a recap of data in tabular form regarding the types of product defects at company X in January-February 2023.

Table 1 Polyester Finished Fabric Production Report of Company X Karawang January-February 2023 Period.

No	Production Quantity	Defective Standard	Amount of Defects	Defect Percentage
1	132.456	2%	7.234	5.4%
2	142.054	2%	7.821	5.3%
3	130.159	2%	7.040	5.3%
4	132.723	2%	7.229	5.3%
5	135.251	2%	7.671	5.4%
6	132.189	2%	7.255	5.4%
7	137.402	2%	7.661	5.4%
8	130.159	2%	7.040	5.3%
9	132.723	2%	7.229	5.3%
10	135.251	2%	7.671	5.4%
11	132.189	2%	7.255	5.4%
12	130.159	2%	7.040	5.3%
13	135.251	2%	7.229	5.4%
14	132.189	2%	7.671	5.3%
15	137.402	2%	7.255	5.4%
<b>Total</b>	<b>2.007.557</b>	<b>2%</b>	<b>110.301</b>	<b>5.4%</b>
<b>Average</b>	<b>133.837</b>	<b>2%</b>	<b>7.353</b>	<b>5.4%</b>

data in table 1 the number of defects in Polyester fabric products occurs quite high and is not in accordance with the standards set by the company. The average number of products that experience kecatatan is around 7,353 with a percentage reaching 5.4% of total production each month. Problems that arise from the production of polyester fabrics that result in losses in the cost of goods based on defects. From the data that has been collected, it is necessary to study it using a method or tool to minimize the possibility of defects. One method that can be applied to identify problems of prioritizing product improvement and types of failures in the production process is to use the Failure Modes and Effects Analysis (FMEA) method. The use of this method is expected to improve the quality of products from company X.

## 2. LITERATURE REVIEW

### A. Quality Definition

Quality is a dynamic condition related to products, services, people, processes, and the environment that meet or exceed expectations (Sugiarto, 2003). This definition is in line with the understanding put forward by Feigenbaum (1991), quality is the overall characteristics of products and services which include marketing, engineering, manufacture, and maintenance, where these products and services in use will meet customer needs and expectations.

The concept of quality itself is a relative concept, which depends on one's perspective in forming standards on a product or service. However, there are aspects that can be used as a reference for the fulfillment of quality in a product, namely aspects of availability, delivery, reliability, maintainability and cost effectiveness as stated by Crosby. Meanwhile, according to Lupiyadi (2006) quality has eight measurement dimensions consisting of the following aspects:

1. Performance is an aspect that includes brand, measurable attributes, and aspects of individual performance.
2. Features are aspects of product diversity that are usually measured subjectively by each individual (in this case consumers) which indicate differences in the quality of a product.
3. Reliability is an aspect of the reliability of a product which indicates that the level of quality is very meaningful for consumers in choosing products.

4. Conformance is an aspect of the suitability of a product in the industry that is measured by the level of accuracy and completion time including the calculation of errors that occur, delays that cannot be anticipated, and several other errors.
5. Durability is durability or durability, technically durability is defined as the number of uses that a person gets before experiencing a decrease in quality. Economically, durability is defined as the economic life of a product seen from the number of uses obtained before damage and the decision to replace the product.
6. Serviceability is a service capability that can also be called speed, competition, usability, and ease of product repair.
7. Aesthetics is the aesthetics of a product seen from how a product sounds to consumers, how the outer appearance of a product, taste, and smell.
8. Perceived Quality is an aspect of consumers not always getting complete information about product attributes. But generally, consumers have information about products indirectly.

### B. Quality Control

Statistical quality control is the application of statistical principles and techniques at every stage of production directed towards making a product in the most economical way so as to achieve the maximum possible benefit and have a market (Deming, 1982). Meanwhile, according to the American National Standard Institute (1996) Quality control is a technique and operational activity that pays attention to the quality of a product or service that will affect certain needs.

### 3. METHODS

This research uses the FMEA or Failure Modes and Effects Analysis research method. FMEA is a structured research procedure with the aim of identifying and preventing as many failure modes as possible. According to Stamatis (2003) FMEA is a research technique that is applied with the intention of identifying the existence or potential failure or problem in the design, process, or structure of system services before the failure occurs, to prevent unwanted incidents and protect workers from work accidents or other adverse effects by taking the necessary actions.

FMEA is classified as a semi-qualitative method. The Risk Priority Number (RPN) in FMEA supports quantitative analysis of risk events. This method not only finds the highest risk accurately and quickly but also overcomes concerns about information loss. The severity and type of potential failures in the system are analyzed and identified by FMEA thus enabling decision-makers to take necessary risk-reduction actions (Sharma & Srivastava, 2018).

### 4. RESULT AND DISCUSSION

#### Identification of Number of Defect Frequencies in Polyester Fabrics

The identification process is a stage to identify the number of frequencies that can cause defects in Polyester Fabric production. It is intended to know what types of defects often occur and the impact of the occurrence of failures that affect the production process. The results of the identification of the Number Frequency of Polyester fabric defects can be seen in Table 2

Table 2. Number of Frequency Type of Defects Polyester Fabric

No	Fabric Defect Type	Amount of Defects	Presentence
1	Oil spots	10.013	13.4
2	White spots	26.094	20.4%
3	Striped Folds	16.051	16.6%
4	Chemical/ Colour spots	53.210	44.7%
5	Uneven colours	2.076	2.9%
6	Colour does not match	1.657	1.2%
7	Weft/woven line	1.200	0.8%
<b>Total</b>		<b>198.284</b>	<b>100%</b>

Based on table 2, it can be seen that the largest type of defect that occurs in the production of Polyester fabrics in the January - February period is the type of Chemical defect or colour spot defect with a total of 53,210 meters with a percentage of 44.7%, then the second largest number of defects occurs in the type of white spot defect with a total of 26,094 meters with a percentage of 20.4%, then the third largest number of defects is the striped fold defect with a total defect of 16,051 meters with a percentage of 16.6%, then several other defects such as oil spots, inappropriate colours, uneven colours and weft / warp lines which each occur with a percentage of 13.4%, 2.9%, 1.2%, 0.8%. with the results of identifying these types of defects, the priority for improvement in production defects that must be repaired first is Chemical defects / colour spots.

### Determine Risk Priority Number (RPN)

According to Liu et al., (2013) in identifying factors to be at risk of defects in products is done by conducting an analysis based on the Risk Priority Number (RPN) obtained by multiplying three risk factors, namely: Occurrence (O) or the likelihood of failure, Severity (S) or the severity of failure and detection (D) or the capacity for failure detection before failure occurs ( $RPN = O \times S \times D$ ). To calculate RPN, these three factors need to be evaluated using pre-defined scales. FMEA prioritizes failure modes based on the assumption that the higher the RPN of a failure mode, the greater the risk for product failure as well as low quality.

At this stage, RPN is assigned to several failure modes that cause colour or chemical spots on polyester fabrics. The results of the RPN determination can be seen in Table 3.

Table 3. Result of RPN Determination of Failure Modes Colour / Chemical Fleck Defects

No	Failure Mode	O	S	D	RPN
1	Incomplete dissolution of medicine	9	8	5	360
2	No Drug Screening Process	7	8	5	280
3	Poor Quality of Dystuff	8	5	6	240
4	Dirty Hot Air Filter	8	6	4	192
5	Poorly maintained roller cleanliness	7	6	4	168
6	Negligent equipment inspection & maintenance	7	6	3	126
7	Obsolete/outdated dissolution method	6	6	3	108
8	Poor coordination between operators	8	2	6	96
9	Unorganized drug arrangement	8	2	4	64

### Analysis of Causes of Defects in Polyester Fabrics

Analyze the factors that cause defects in the production of Polyester fabrics, namely:

1. Human Factors
  - a. The cause of defects in Polyester fabrics occurs due to the lack of discipline of the operators when working on the drug dissolution process, causing the drug dissolution to be less than perfect.
  - b. The lack of discipline of the operators in the screening stage of the drug. This happens when the results of drug dissolution will enter the machine often there is no filter so that the drug is not used does not pass through a good filtering process.
2. Material Factor
 

The poor quality of Dyestuff is due to the fact that the Dyestuff materials used are materials that have been stored for a long time so that their quality has decreased.
3. Machine Factor
  - a. The hot air filter on a dirty engine caused by engine cleaning in the hot air filter section is quite difficult to do because the engine parts are difficult to disassemble so the hot air filter cleaning process is often missed.
  - b. The cleanliness of the rollers is poorly maintained because there are so many rollers in one machine that it becomes difficult to pay attention to the cleanliness of each roller in the machine.
  - c. Lack of re-examination of the tools used and minimal maintenance of the machines used.

4. Method Factor
  - a. The applied dissolution method is outdated. The dissolution conditions used may no longer support the characteristics of the current drugs (the drugs currently used are not compatible with the dissolution method used).
  - b. Lack of coordination among operators when taking or using Dyestuff or Chemical in accordance with the standard.
5. Environment Factor
 

The medicine storage area is not neatly arranged and the lack of air circulation makes the room stuffy and hot.

### Proposed Improvements

Proposed improvements to the problem are based on the results of the analysis of the causes of defects in polyester fabrics. The results of the proposed improvements are presented in Table 4.

Tabel 4. Proposed Improvements

Factor	Problems	Proposed Improvements
Human	Incomplete dissolution of medicine	Create a checking mechanism by giving OK or NO marking points by the team leader to ensure that the dissolution of the medicine has been done well so that it dissolves completely. Improve competencies including knowledge understanding and discipline of the head of the team in supervising and rechecking the performance of employees of their team members so as to minimize the occurrence of errors caused by human negligence or human error.
	No Drug Screening Process	Make improvements to the drug screening equipment and always check the state of the screening that is always available on the machine so as to minimize operator negligence. Impose strict sanctions on negligent operators who intentionally skip the drug screening process. Conduct more frequent supervision and direction of machine operators to work better and be more disciplined.
Material	Poor quality of Dyestuff or Chemical	Conduct a solubility test on the materials used first Perform a good calculation of the amount of production to be carried out so that the purchase of raw materials can be purchased according to the amount needed and conduct periodic checks on the stock of unused raw materials and separate them from the stock of new materials. Implement a process of rechecking the materials received from suppliers to test whether the materials received are in accordance with the standards imposed by the company.
Machine	Dirty hot air filter in the engine	Periodic maintenance by a qualified technician covers the feasibility of the engine and the cleanliness of engine parts that are difficult to clean such as the hot air filter in the engine.
	The rollers through which the fabric passes are not clean/not in a condition that is free of	Tighten the roller washing process when the colour used in the previous process is darker or darker so that it does not affect the next fabric which has a

	traces of the previous fabric colour	lighter colour so that the colour results of the fabric are not mixed and can be obtained according to the colour results.
	Lack of machine checks and lack of maintenance of the machines used	Conduct periodic check pickets on the machine before and after use to ensure the machine is in good condition.
Method	Expired dissolution method	Conduct tests with careful dissolution by entering several variables such as different temperature variations and the length of the chemical stirring process so that the most effective method for dissolving the material is found.
	Lack of coordination between workers/operators	Always conduct work briefings and create an organized workflow so that we can work intensively and in synergy.
Environment	Medicine storage is not neatly organized	Organize neatly by grouping drugs based on their functions to make it easier to retrieve and store again. In addition, provide an exhaust fan so that air circulation becomes smooth.

After going through the process of determining the RPN and FMEA, the prioritization of improvements to the system is obtained to improve the quality of polyester fabric production. Proposed improvements have been determined based on the determination of RPN and also grouping the causes of defects based on the problem factors. The proposed improvements will then be taken into consideration by the company to make efforts to improve the quality of polyester fabric in company X.

## 5. CONCLUSION

The results of the analysis in this study indicate that in Company X there are 7 types of Production Defects with colour fleck defects which have the highest percentage of occurrence which is 44.7% and is a priority for improving the quality of Polyester fabrics. Then there are 9 types of failure modes that occur in colour spots / Chemical defects which are divided into 5 causal factors, namely, Human factors (Human), Raw materials (Material), Machines (Machine), Methods (Method), and Environment (Environment). The five factors that cause fabric production defects have a significant influence in reducing fabric quality. Of the five factors above, the human factor is a factor with a failure mode that has the highest RPN, namely in the failure mode of incomplete drug dissolution with RPN 360. This is due to negligence that occurs in workers besides the absence of a mechanism that specifically sets a good standard in determining whether the drug has dissolved perfectly or not. The analysis of the factors causing defects and the formation of improvement proposals have been made by considering the company's situation so that the proposals that have been made can be taken into consideration by the company in helping efforts to improve the quality of Polyester fabrics.

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