

PROPOSED IMPROVEMENT OF THE SCREEN T-SHIRT QUALITY PRODUCTS AT PT. INDO ANUGERAH SEMESTA

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Abstract. PT. Indo Anugerah Semesta is a company that produces t-shirts. This company has a problem, namely defective products as much as 15% of the total production so that it exceeds the standard limits that have been set by the company. It is necessary to improve this matter by using the Failure Mode and Effect Analysis (FMEA) and Fault Tree analysis (FTA) methods. Based on the results of FMEA there are 35 values of Risk Priority Number (RPN) and the results of Pareto there are 6 failure modes with 16 causes of failure which will be searched for the root of the problem. The result of the FTA is that there are 15 root causes. The recommendations given are maintenance of machines and production equipment, making SOPs, evaluating the physical work environment, clarifying the responsibilities of each division.

INTRODUCTION

During the current COVID-19 pandemic, many companies have to maintain or improve the quality of their products so that companies can compete with other companies so that they can dominate the existing market. PT. Indo Anugerah Semesta is an industry that focuses on producing clothing products with various types of products, one of which is screen printing T-shirts. The company has a problem with the defective products of screen printing T-shirts. PT. Indo Anugerah semesta experienced an increase in order on screen printing T-shirt products by 57% of the overall product. Screen printing shirts always experience defects exceeding the standard limits set by the company. The tolerance limit allowed by the company is 2% per work station. The company has never identified the problem so research is needed to make improvements to reduce the number of defects in the screen printing T-shirt manufacturing process.

RESEARCH METHODOLOGY

Data Collection

The required datas for this research are :

1. Production Process
2. Production Process Flow
3. Product Production Data
4. Defective Product Data

Data Processing

Failure Mode and Effects Analysis (FMEA)

The value calculation and analysis for each production is carried out by looking at several stages according to [1]:

- a. Identify the type of production process failure (*Failure Mode*)
- b. Identify potential effects of production failure (*Failure Effect*)
- c. Identify potential causes of failure (*Cause of Failure*)
- d. Identify process control (*Current control*)
- e. Determine the severity value (S)
- f. Determine the value of occurrence (O)
- g. Determine the detection value (D)
- h. Determine the value of the Risk Priority Number (RPN)
- i. Ordering of Risk Priority Number value (RPN)

Pareto Diagrams

Pareto diagrams will be searched to determine the priority of the Risk Priority Number (RPN) value in order to focus on finding the root cause of each failure mode and cause of failure by creating a Pareto diagram with the principle of 80/20 and as an input for analysis using the Fault Tree Analysis (FTA) method.

Analysis and Proposed Improvements

Fault Tree Analysis (FTA) is used to analyze the root cause of each failure mode and cause of failure by performing several stages according to [2]:

- a. Define the problem and boundary conditions of a system under review
- b. Fault tree graphic model depiction
- c. Finding the minimum cut set from fault tree analysis
- d. Conduct qualitative analysis of fault tree

Determination of minimum cut set using qualitative analysis with Boolean Algebra theory according to [3]:

- a. Putting together each fault tree chart for each defect that has been made
- b. Make a description table on the overall fault tree chart
- c. Numbering the entire fault tree chart
- d. Perform calculations to get a cut set that will be given a proposed improvement

Furthermore, it provides a proposed improvement based on the root of the problem obtained from the cut set results to minimize or eliminate known defects by making an improvement to the production of screen printing T-shirt products so that defects do not occur again.

Conclusions and recommendations

This research will result some recommendations for quality improvements to reduce the occurrence of defects during the production process. The recommendations submitted are the result of data processing that has been done and formulated in the analysis section.

RESULTS AND DISCUSSIONS

Data Collection

Production Process

The production process is a way to produce existing products. Production process at PT. Indo Anugerah Semesta conducts production by passing several machine processes, namely cutting machines, screen printing, curing, obras, chains, overdecks, checking.

Production Process Flow

Product process flow as information for production process instructions for screen printing T-shirt products. The process of working on 1 screen printing shirt product there is a processing time of 83 minutes and a product time of 64 minutes.

Product Production Data

Production data is obtained to see the amount of production each month in order to know the percentage of defects in screen printing T-shirt products. Production data obtained from PT. Indo Anugerah Semesta in marketing manager as many as 17600 screen printing T-shirt products in January 2020 to July 2021.

Defective Product Data

Flawed product data obtained from interviews with operational managers is viewed from each work station. Defective product data is used to look for the percentage of defects that occur in screen printing T-shirt production data. Defective product data shows the type of defect at each work station with the number of defective screen printing T-shirt products held by different operators when conducting the production process. Data and presentation of defective products can be seen in Table 1.

TABLE 1. Data and Percentage of Defective Products

No	Work Process	Work Station	Type of Defect	Defect Percentage
1	Making the front and back of screen printing shirts (O-1 , O-2)	Cutting Machine	The size of the front / back is too big	1,51%
			The size of the front / back is too small	
2	Making the hand part of screen printing t-shirts (O-4)	Cutting Machine	The size of the front / back is too big	1,54%
			The size of the front / back is too small	
3	Printing (O-8)	screen printing	wrong color	2,85%
			Wrong precision	
			Wrong position	
...
8	Checking and packing (O-11 & I-1)	Checking Desk	T-shirt Screen Printing	2,55%
			Bolong Burned	

Data Processing

Failure Mode and Effect Analysis (FMEA)

The following is the processing of data based on the data that has been obtained for the improvement of problems that occur in PT. Indo Anugerah Semesta is:

a. Identify the type of production process failure (Failure Mode)

The first stage is the identification of the type of defect of the production process to find out the source where the damage occurs. Failure mode is the most important step in the use of the Failure Mode and Effect Analysis (FMEA) method. The results of identification of the type of defect are obtained through interviews and identification of the production process. Failure mode can be seen in Table 2.

TABLE 2. Failure Mode

NO	Work Station	Type of Production Process Defect (Failure Mode)
1	Cutting Machine	The size of the front / back of the screen printing shirt is too big
2		The size of the front / back of the screen printing shirt is too small
3		The size of the sleeve of the screen printing shirt is too big
4		The size of the sleeve of the screen printing shirt is too small
...

12	Checking Desk	Burning perforated screen printing t-shirt
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b. Identify potential effects of production failure (Failure Effect)

The second stage identifies the potential effects of failure on the production process. The results of identification of the type of defect are obtained through interviews and identification of the production process. Failure Effect can be seen in Table 3.

TABLE 3. Failure Effect

NO	Work Station	Type of Production Process Defect (Failure Mode)	Potential Effects of Production Failure (Failure Effect)
1	Cutting Machine	The size of the front / back of the screen printing shirt is too big	Materials must be reworked
2		The size of the front / back of the screen printing shirt is too small	The material must be reworked (become part of the arm)
3		The size of the sleeve of the screen printing shirt is too big	Materials must be reworked
4		The size of the sleeve of the screen printing shirt is too small	Goods are rejected, and cannot be reworked
...
12	Checking Desk	Burning perforated screen printing t-shirt	Reject items, and cannot be reworked

c. Identify potential causes of failure

The third stage is the identification of potential causes of failure in the production process. The results of identification of the type of defect are obtained through interviews and identification of the production process. Cause of failure can be seen in Table 4.

TABLE 4. Cause of Failure

NO	Work Station	Type of Production Process Defect (Failure Mode)	Potential Effects of Production Failure (Failure Effect)	Potential Causes of Failure (Cause of Failure)
1	Cutting Machine	The size of the front / back of the screen printing shirt is too big	Materials must be reworked	Job specialization does not exist so that it affects operator performance
2				Wrong pattern creation
3				an unfavorable work environment that affects operator performance
...
35	Checking Desk	Burning perforated screen printing t-shirt	Reject items, and cannot be reworked	Smoking Operator

d. Identify process control (Current Control)

The fourth stage is the identification of the control process in the production process. The results of identification of the type of defect are obtained through interviews and identification of the production process. Current control can be seen in Table 5.

TABLE 5. Current Control

NO	Work Station	Type of Production Process Defect (Failure Mode)	Potential Effects of Production Failure (Failure Effect)	Potential Causes of Failure (Cause of Failure)	Process Control (Current Control)
1	Cutting Machine	The size of the front / back of the screen printing shirt is too big	Materials must be reworked	Job specialization does not exist so that it affects operator performance	Perform a visual inspection by the operator by measuring using a meter
2				Wrong pattern creation	
4				an unfavorable work environment that affects operator performance	
...
6	Checking Desk	Burning perforated screen printing t-shirt	Reject items, and cannot be reworked	Smoking Operator	Perform a visual inspection by the operator by measuring using a meter

e. Determining the Severity Value

Severity value is a value in the form of a rating or assessment obtained from an impact that can affect the final product. Determination of severity value obtained is the result of discussions with the company by looking at the company's criteria. Severity values can be seen in Table 6.

f. Determining the Occurrence Value

Occurrence value is an assessment that refers to the frequency of product defects and will be compared to the number of products produced. The results of determining the occurrence rating by looking at the company's criteria are obtained from the results of discussions with the company. Occurrence values can be seen in Table 6.

g. Determining the Detection Value

Detection values are used to prevent or determine failures that may occur and will affect subsequent processes in the production and assembly process. The results of the determination of rating detection by determining the company's criteria are obtained from the results of discussions with the company. Detection values can be seen in Table 6.

h. Determining the Value of the Risk Priority Number (RPN)

Determines the Risk Priority Number (RPN) value using the main variables in FMEA namely severity, occurrence, and detection. Risk Priority Number (RPN) serves to determine the value / weight rating of each failure. After looking at the type of defect (Failure mode) obtained. Determining the Risk Priority Number (RPN) can be seen in Table 6.

i. Ordering of Risk Priority Number (RPN) Values

After getting the Risk Priority Number (RPN) value from each screen printing T-shirt manufacturing process, it will be sorted the highest to lowest values so that further research can be done using the Fault Tree Analysis (FTA) method. The sorting of Risk Priority Number (RPN) values can be seen in Table 6.

TABLE 6. Ordering of Risk Priority Number (RPN) Values

NO	Work Station	Type of Production Process Defect (Failure Mode)	Potential Causes of Failure (Cause of Failure)	<i>S</i>	<i>O</i>	<i>D</i>	RPN (Risk Priority Number)
1	Curing Machine	Fade	Machines that have never been repaired	10	7	7	490
2			Unstable engine heat	10	7	7	490
3			The drying process is not optimal	10	6	7	420
4			Old dry screen printing material	10	6	7	420
...
35	Overdeck Machine	Free Stitch	Inappropriate sewing process	4	3	4	48

Table description:

S = Severity, *O* = Occurrence, *D* = Detection

Pareto chart

After the sorting of the highest risk priority number (RPN) value to the next lowest is to determine the priority of improvement using the Pareto diagram. The function of the Pareto diagram here is to determine which priorities will be searched for the root of the problem using the Pareto 80/20 principle. The Pareto diagram can be seen in Figure 1.

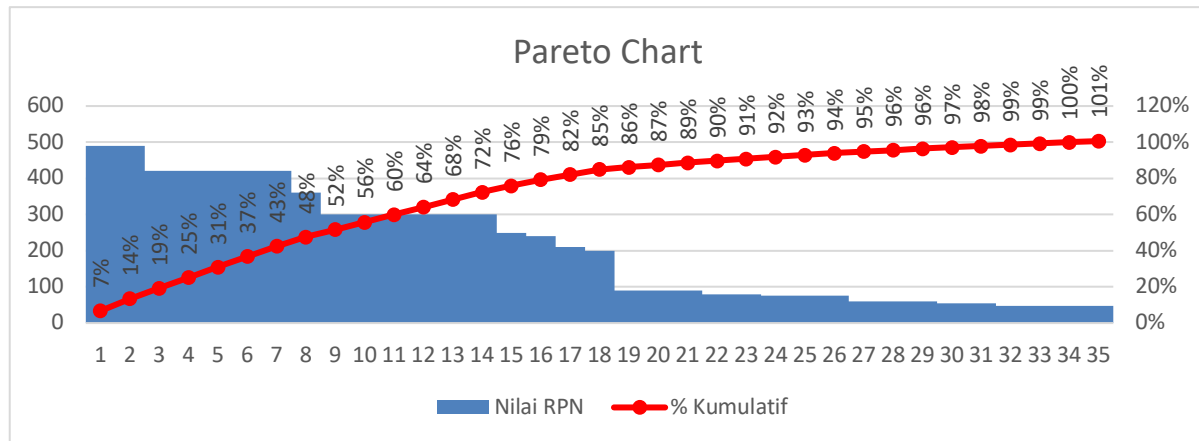


FIGURE 1. Pareto Chart

The description of the picture can be seen in Table 8.

TABLE 8. Description Of Image

No	Type of Production Process Defect (Failure Mode)	Potential Causes of Failure (Cause of Failure)
1	Fade	Machines that have never been repaired
2		Unstable engine heat
3		The drying process is not optimal
4		Old dry screen printing material
5	Wrong color	Inappropriate color mixing process
6	Wrong precision	Job specialization does not exist so that it affects operator performance
7	Wrong position	Job specialization does not exist so that it affects operator performance
8	Wrong color	Job specialization does not exist so that it affects operator performance
9	Wrong precision	Screen printing process is not appropriate
10		an unfavorable work environment that affects operator performance
11	Wrong position	Screen printing process is not appropriate
12		an unfavorable work environment that affects operator performance
13	The size of the sleeve of the screen printing shirt is too small	Wrong pattern creation
14		Disturbed operator due to unfavorable work environment
15	Wrong color	The color liquid has not been replaced for a long time
16	Burning perforated screen printing t-shirt	Smoking operator
...
35	loose stitch	Inappropriate sewing process

The result of the Pareto diagram and obtained priority to find the root of the problem is at numbers 1-16. 6 failure mode, and 16 cause of failure:

- The type of defects in curing work stations resulted from machines that never repaired, unstable engine heat, non-optimal drying process, old dry screen printing material dry.
- Types of defects in mis-color, wrong precision, and wrong position at screen printing work stations resulted from the process of mixing colors that do not fit, the specialization of the work does not exist so as to correct the performance of the operator, the cloning process is not appropriate, the work environment is less conducive so that it affects the performance of the operator, color fluids have not been replaced for a long time..
- Type of screen printing T-shirt defects burned at the check desk work station caused by the operator smoking.
- Type of defect in the size of the sleeves of the small screen printing t-shirt resulted from the creation of the wrong pattern, the operator who was disturbed due to a less conducive work environment.

Analysis and Proposed Improvements

After getting any priority that will be sought the root of the problem using the principle of Pareto 80/20, then the root analysis of the problem by using the Fault Tree Analysis (FTA) method.

- fade in the curing process
The analysis of fastness defects in the drying process can be seen in Figure 2.

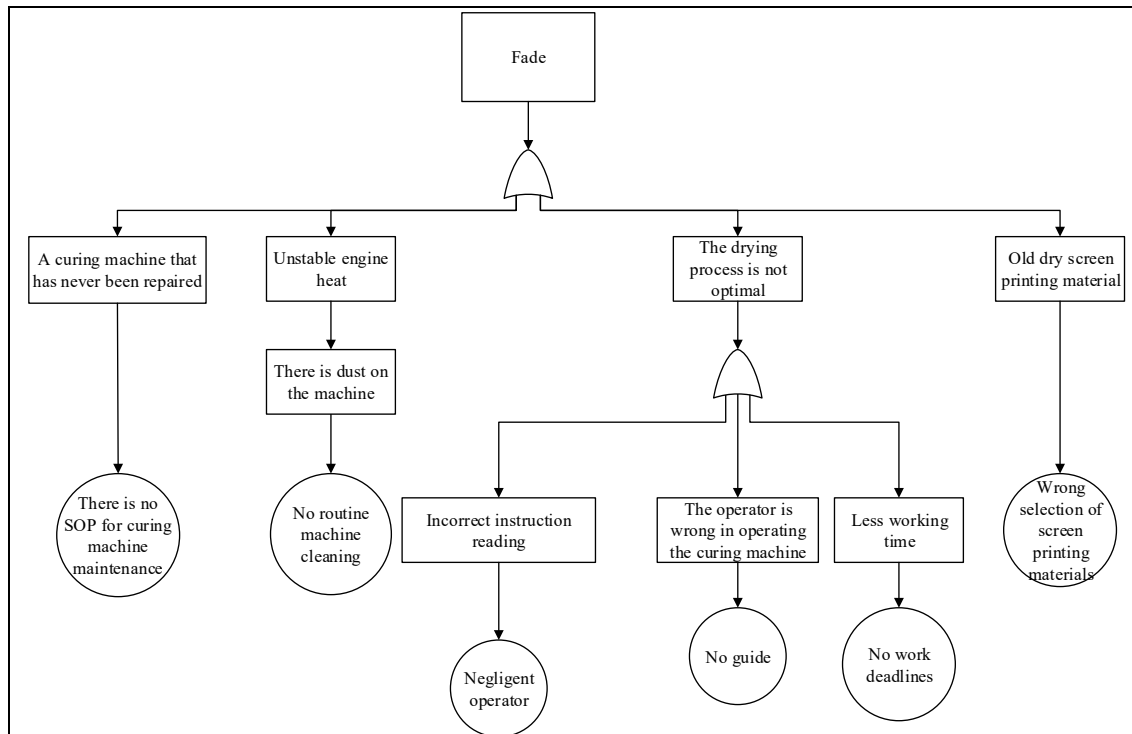


FIGURE 2. Analysis of Fastness Defects in the Drying Process

b. Wrong color in the screen printing process

The analysis of wrong color defects in the screen printing process can be seen in Figure 3.

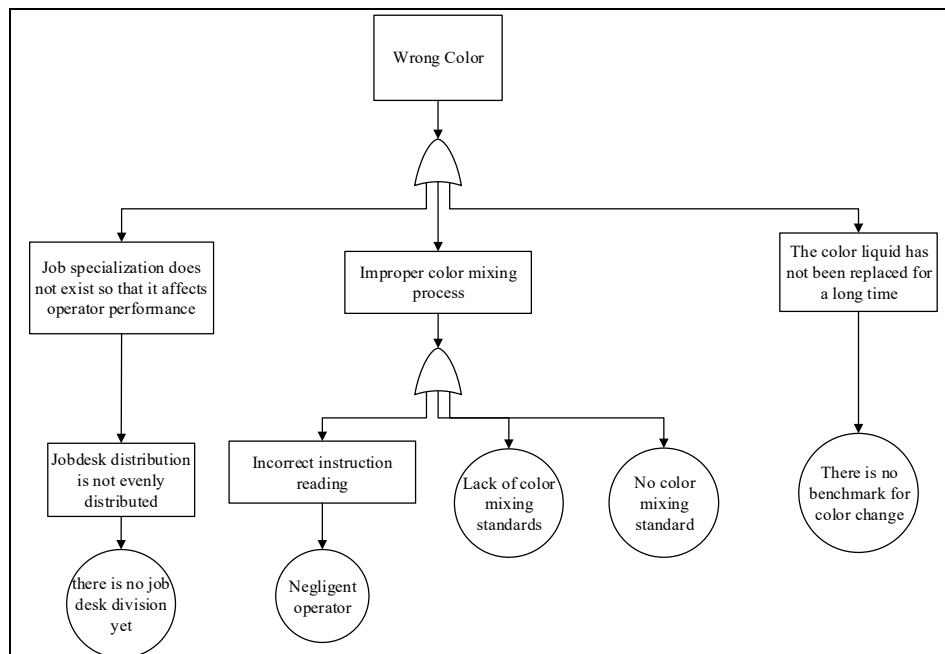


FIGURE 3. Analysis of Wrong Color Defects in the Screen Printing Process

c. Wrong precision in the screen printing process

Analysis of faulty precision defects in the screen printing process can be seen in Figure 4.

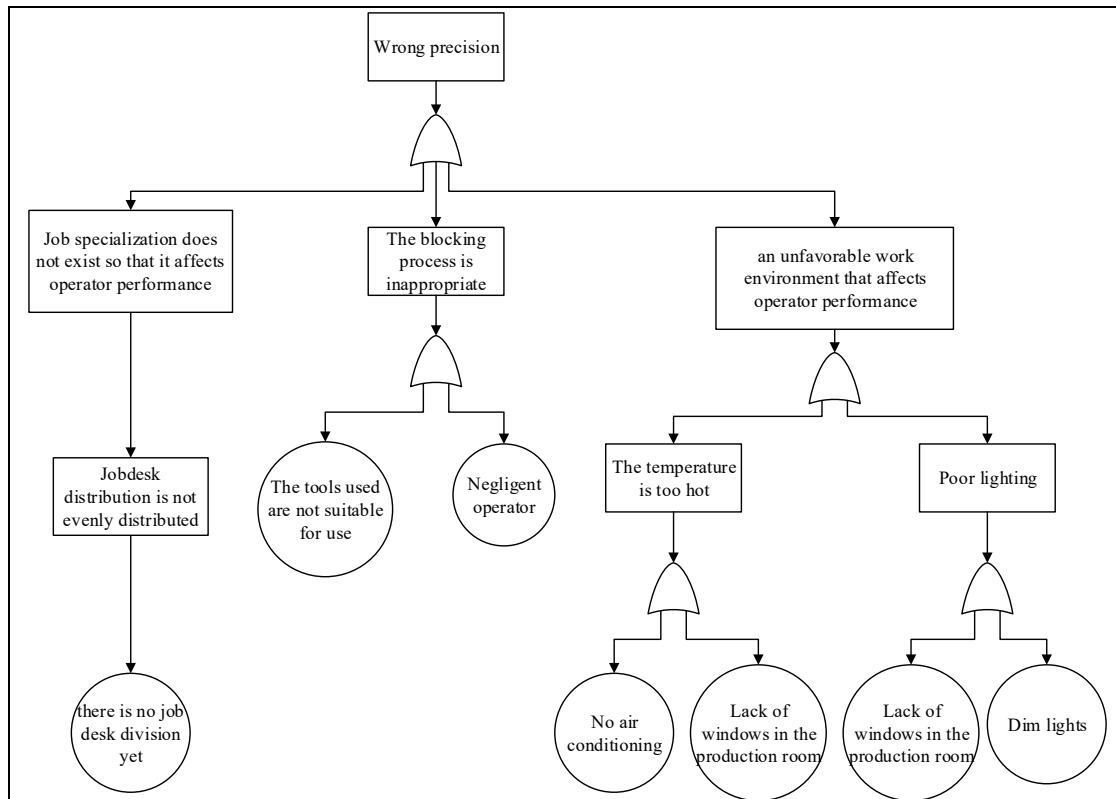


Figure 4. Analysis of faulty precision defects in the screen printing process

d. Wrong position in the screen printing process

The analysis of wrong position defects in the screen printing process can be seen in Figure 5.

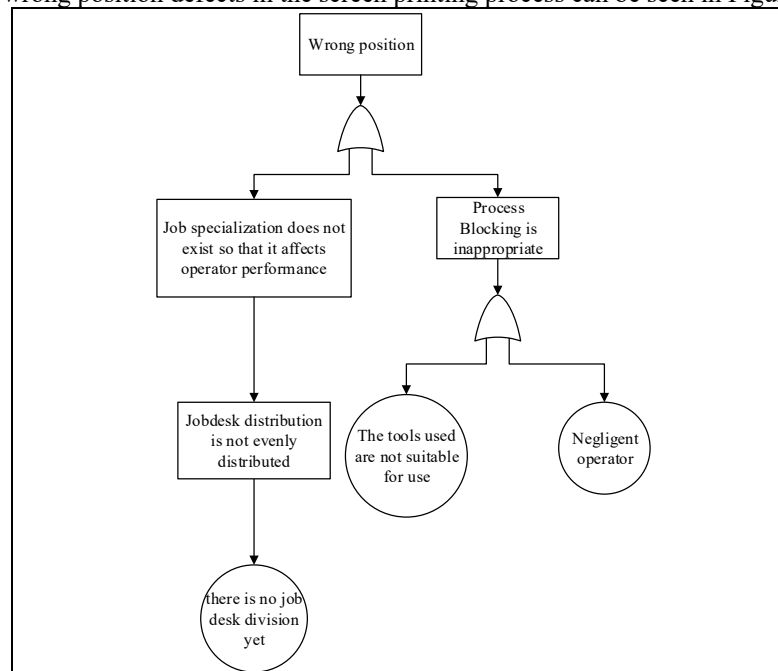


FIGURE 5. Analysis of Wrong Position Defects in the Screen Printing Process

- e. Printing shirt is burned in the checking process

The analysis of defects in the screen printing t-shirt in the checking process can be seen in Figure 6.

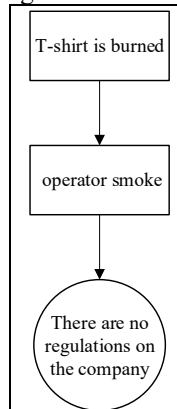


FIGURE 6. Analysis of the Defects of the Screen Printing T-shirt in the Checking Process

- f. The size of the sleeves of the screen printing shirt is too small in the cutting process.

Analysis of the size defect of the sleeve size of the screen printing shirt smallness in the cutting process can be seen in figure 7

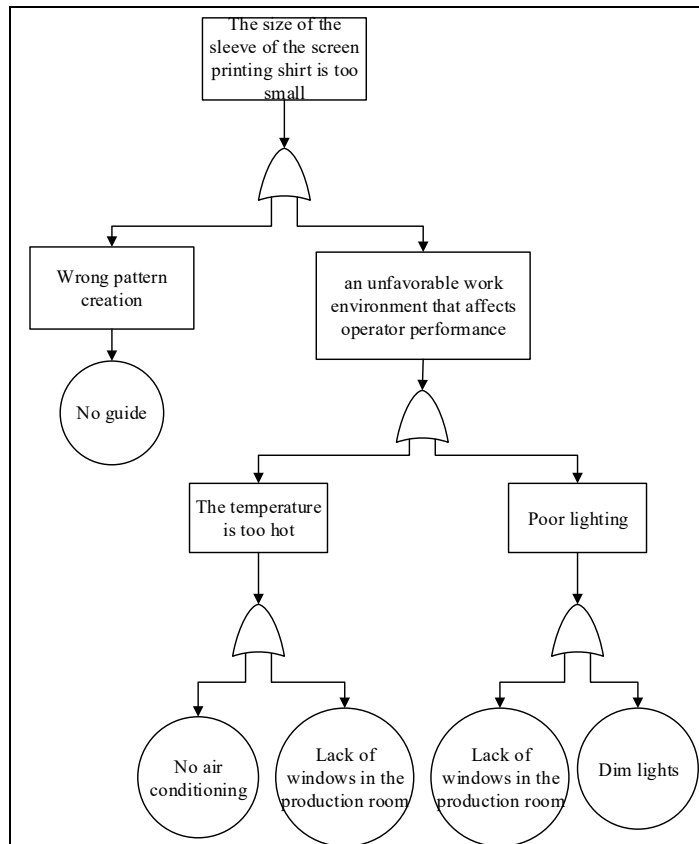


FIGURE 7. Analysis of Defects in Arm Size of T-shirt Screen printing Smallness In The Cutting Process

Furthermore, the determination of the minimum cut set using the Boolean Algebra method so that it gets 15 root problems overall failure mode and cause of failure and will be sought proposals to the root of the problem can be seen in Table 9.

Table 9. Improvement Proposal

Number	Root cause of Disability	Company Condition	Improvement Proposal
1	No SOP curing machine maintenance	Curing machines often have problems	Perform regular maintenance and make spare part changes
2	Wrong selection of screen printing material	Long-used screen printing material dry	The company must re-research the screen printing material used
...
12	There is no air conditioning	The production room is hot and has a few fans	Conduct further evaluation of the physical work environment
13	Lack of windows in the production room	Many rooms don't have windows	
14	Less bright lights	Inadequate room lighting	
15	There is no jobdesk division yet.	the operator works on all work stations	Create special divisions that are each responsible for one work station or one job

CONCLUSION

Based on the results of data processing and analysis, several conclusions were obtained, namely:

- The type of defects in curing work stations resulted from machines that never repaired, unstable engine heat, non-optimal drying process, old dry screen printing material dry.
- Types of defects in mis-color, wrong precision, and wrong position at screen printing work stations resulted from the process of mixing colors that do not fit, the specialization of the work does not exist so as to correct the performance of the operator, the cloning process is not appropriate, the work environment is less conducive so that it affects the performance of the operator, color fluids have not been replaced for a long time.
- Type of screen printing T-shirt defects burned at the check desk work station caused by the operator smoking.
- Type of defect in the size of the sleeves of the screen printing shirt smallness caused by the creation of the wrong pattern, a less conducive work environment that affects the performance of the operator.

Recommendations for improving the quality of PT. Indo Anugerah Semesta as follows :

- The company must perform periodic maintenance of the machines and tools used so that the production process can be carried out optimally.
- The company must follow clear regulations or Standard Operating Procedures (SOPs) in every production process to be clear in doing something.
- Companies should conduct further evaluation of the physical work environment in order to increase productivity in operators.
- Companies are supposed to create special divisions that are each responsible for one work station or one job.
- The company should re-research the color mixing and liquid use policy as well as the selection of good quality screen printing materials.
- The company provides rewards or punishments to operators in order to increase the morale of the operator.
- The company must conduct supervision of the operator while the production process takes place.

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