Analysis of Product Defect to Reduce Return Product in Flexographic Printing

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ABSTRACT

Product return in 2021 at PT XY increased, but the quality control implemented has not been running effectively. This study aims to analyze the failure risk that causes defects, gets the greatest failure risk in the Risk Priority Number (RPN), and gives suggestions for improvement for the next production. The focus of this study is on production defects that are returned by customers. This study used Failure Mode Effect Analysis (FMEA) methods and Problem Identification Corrective Action (PICA) table. From the gathered data, it is identified that there is one type of dominant defect that is outside the control limits. The results of data processing by multiplying the SOD value to get the RPN value found that the three largest ranking modes of failure were the engine settings did not match the RPN value of 484, negligent in the production control process with the RPN value is 230, and the compressor is not optimal with the RPN value is 210. Then an analysis was carried out using the PICA table to get suggestions for improvements, conducting periodic IK retraining, checking machine condition regularly, conducting periodic inspections during the production process, evaluating performance results, and running check sheets while carrying out the production process.

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1. INTRODUCTION

Products with good quality will certainly increase customer loyalty. Increasing the quality of customers will certainly increase the company's sales and production cycle (Grace et al., 2021). Industries that do production in big amounts will need existence to control the quality carried out by the company either by controlling the quality directly to the production or by carrying out routine activities that analyze quality control (Attaqwa et al., 2021; Yulianto & Wahyuni, 2021).

The Failure Mode and Effects Analysis (FMEA) is a methodical procedure for detecting every potential flaw in a design, production, or assembly process, product, or service (Gupta, 2023). It is a structured approach to discovering potential failures that may exist within the design of a product or process. The goal of FMEA is to reduce costs and problems that may lead to expensive recalls by identifying and ranking potential problems and their effects. FMEA is used to proactively look for errors earlier in the dispensing process (Anjalee et al., 2021). The benefits of FMEA include improved product and process reliability, quality, and safety, identifying and eliminating or reducing potential product and process failures, documenting and organizing shared knowledge for current and future use, reducing costs and problems later in the product lifecycle, and better prioritizing actions that decrease the risk of failure (Wang et al., 2022). FMEA has been used in various industries, including the manufacturing industry, to identify system, product, and process improvements early in the development cycle and to prioritize actions that decrease the risk of failure.

This research was conducted at PT XY which is a manufacturing company that uses flexographic printing techniques. To carry out quality control, PT XY has a QC/ QA division that is responsible for supervising and

carrying out quality control. Although quality control has been carried out, the activities carried out are still not effective, in other words, there are still defective products. Industry must consolidate to prevent and reduce defective products so that the quality of products produced is maintained because complaints from the customers indicate a gap or customer dissatisfaction with the industry.

The authenticity of this work consists, precisely, of analyzing and reducing defects in products involving customer dissatisfaction (Imaningsih, 2018) when receiving the products. Dissatisfaction among customers occurs because quality control from the product is not running effectively. This research uses the FMEA method for identifying the highest value of risk failure. A possible process failure mode is its methods. Effects are how these mistakes can cause waste, flaws, or negative results for the client. To identify, prioritize, and restrict certain failure modes, failure mode, and effects analysis is used. The PICA table for designing action corrective for minimizing disability and improving quality. Based on the previous journal, they are just analyzing the highest priority number without designing action to solve the problem. The purpose of this research is to analyze the risk failure that causes risk failure highest and provide suggestions for improvement to minimize defects that use the FMEA and PICA methods. This paper focuses on packaging label defects and uses customer return data with destination research.

2. METHODS

2.1. Framework study

This study focuses on quality control at PT XY which has not been effective in its production. Ineffective quality control effective is caused by many defects on the packaging label so the return customers at the company increases. These problems need to be analyzed more deeply to find the reason for the highest failure in RPN value and provide suggestions for improvement to minimize defects. Figure 1 presents the framework study.

2.2. Data collection method

Required data in this study is primary data based on interviews about control quality and secondary data sourced from customer return data in the period February 2021 – December 2021. This type of data is quantitative and includes the amount of production and type of disable along with the amount returned by the customer. Qualitative data is obtained through information about defects and their causes. The population in the study is the amount of returned customers whereas the object of research is the amount defect product. The data collection methods is shown in Table 1.

2.3. Data analysis method

Data processing in this study was carried out using the FMEA method (Failure Mode Effect Analysis) and the PICA method (Problem Identification and Corrective Action). According to (Würtenberger et al., 2014), the FMEA method could be used to minimize as well as identify failure causes that could make product defects. According to (Anderson & Fagerhaug, 2006) the PICA (Problem Identification Corrective Action) method can be used as a solution to solve the root problems that occur in the company in detail.

2.3.1. FMEA (Failure Mode Effect Analysis)

According to Siregar & Siregar (2018) and Bangun (2022), the purpose of FMEA is to identify and assess the associated risk (RPN value) with potency failure. Determination of RPN value focuses on risk priority failure in causing defects in production results (Chen et al., 2010). The value of the Risk Priority Number (RPN) is used to determine the order of priority (Nurwulan & Veronica, 2020). RPN value obtained from results multiplication among each level of severity, occurrence, and detection (Sahu, 2020) (Wulandari et al., 2022). RPN value can be calculated using the formula [1] adopted from the journal (Tang et al., 2020):

$$RPN = S \times O \times D \quad (1)$$

Description:
S = Severity value
O = Occurrence value
D = Detection value

2.3.2. PICA (Problem Identification and Corrective Action)

According to (Anderson & Fagerhaug, 2006) PICA is an action planning that is carried out after analyzing the gap and arrangement root problem. PICA can also be used to be valid evidence of an effort to identify and analyze the change from the problem (Cahyono et al., 2022). PICA table content is the main problem, sub-problem, root problem, action correction, due date, and department/ section support.

2.3.3. Face validity

Face Validity is the most basic type of validity because the validity is based on assessment logic about the question instrument. If the question of the content has looked in accordance with the resulting instrument to measure so that it could be said valid (Kaplan & Saccuzzo, 2018). The validation is directly through interviews with supervisor production, head production, finishing supervisors, finishing leaders, production admins, operators, and QC admins who play a role and are responsible during the production process take place. The Respondent has already worked for more than 10 years and has a position that fulfills the criteria.

2.3.4. Validity test

According to (Hayashi et al., 2019), a reliability test is instrument testing that displays what something a tool measuring could be trusted or reliable. Measurement results must be reliable in the sense of having to have a level of consistency. The validity test and reliability test

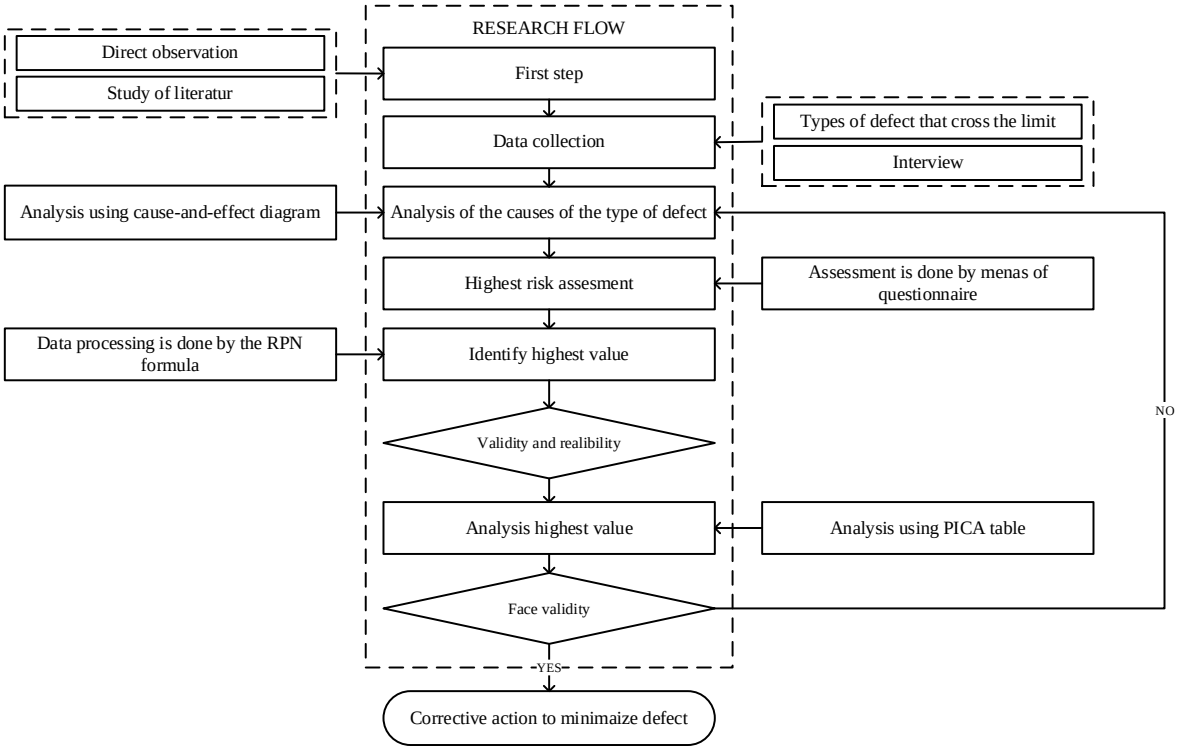

Figure 1. Framework study

Table 1. Data collection methods

Data Source	Required Data	Data Collection Method	Analysis Method
Div. Production	Cause type disabled	Calculation results with SPC method	Cause-and-effect diagram
Div. Finishing	Weight value questionnaire	Interview	RPN value
QC/QA	Design proposal	Questionnaire	PICA value

could be measured using the adapted formulas [2] and [3] (Sürücü & Maslakçi, 2020) described below:

$$r_{xy} = \frac{n(\sum x_i y_i) - (\sum x_i)(\sum y_i)}{\sqrt{(n(\sum x_i^2) - (x_i)^2)(n(\sum y_i^2) - (y_i)^2)}} \quad (2)$$

Description

r_{xy} = Product Moment correlation coefficient
n = number of respondents
x_i = score of each item on the first try
y_i = score of each item on the next try

$$r_i = \frac{k}{(k-1)}\left\{1 - \frac{\sum s_i^2}{s_t^2}\right\} \quad (3)$$

r_i = coefficient Cronbach's alpha reliability
k = number of question items
$\sum s_i^2$ = the number of variance scores for each question
s_t^2 = total variance

To find variance items and variance total, then could use formula [4] and formula [5].

$$s_i^2 = \frac{JKi}{n} - \frac{JKs}{n^2} \quad (4)$$

$$s_t^2 = \frac{\sum x_t^2}{n} - \frac{(\sum x_t)^2}{n^2} \quad (5)$$

Description

s_i^2 = variant of each question
JKi = sum of the squares of all question scores
JKs = amount square subject
x_t = total score

3. RESULTS AND DISCUSSIONS

Based on company data from February - December 2021 using a check sheet obtained results that the type of disabled product along with the amount the defect in PT XY is 9. Out of 9 types disabled there is 1 type defect that goes through limit control that is printing no appropriate. Types of defects that go through limit control the analyzed reason use cause and effect table. Table 2 shows factor reasons from printing is not appropriate.

3.1. Data processing using the FMEA method

From the table of cause and effect (Table 2), it can be identified factor failure that affects production results. From Table 2 can be seen that the reason printing is not in accordance caused by 5 factors that reasons are people, materials, machines, methods, and the environment. After getting the factor causing the defect, calculate the RPN value using the formula [1] based on score severity, occurrence, and detection. The calculation results in the RPN value are shown in Table 3.

Reason printing not in accordance caused arrangement machine not in accordance. Based on the interview and questionnaire, that caused has 7 for severity score, 8 for

Table 2. Cause-and-effect table type no printing defects in accordance

Target	Items	Factors Causing Disability
Printing not appropriate	Human Factor	Negligent in implementation control production Wrong setting schedule.
	Engine Factor	The arrangement machine is not in accordance. Pressure wind or water compressor that does not max / off. Computer slow. Blockage in anilox.
	Environmental Factors	Temperature room no in accordance. Less space storage. Position work no evaluated effectiveness.
	Method Factor	Work pattern inconsistent. Wrong input product.
	Material Factor	Material passes control. Position semi-finished product with no symmetrical/ center.

Table 3. Table of RPN values

Potential Causes	RPN
The arrangement machine is not in accordance	484
Negligent in implementation control production	220
Pressure wind or water compressor that does not max / off	210
Computer slow	204
Less space storage	195
Position work not evaluated effectiveness	185
The temperature room is not in accordance	143
Blockage in anilox	131
Wrong setting schedule	129
Work pattern inconsistent	123
Wrong input product	118
Position semi-finished product with no symmetrical /center	108
Material passes control	84

occurrence score, and 8 for detection score. Then, using the formula [1] the result is shown as follows.

RPN = 7 x 8 x 8

= 484

The result of processing the severity, occurrence, and detection values are the respective RPN values for every failure risk, then prioritized failure risk determined based on ranking order of largest RPN value until smallest RPN value. Then, validation and reliability tests are carried out using the adapted formulas [2] and [3] in the journal (Sürücü & Maslakçi, 2020). Validation and reality tests are used to determine the accuracy of a measuring item in measuring the measured data. Calculation results are shown in Table 4.

The validity test is declared valid if the score r-count > r-table. Based on Table 4 the instrument is declared to be valid. Next conducted reliability test with the use of a formula [3] adopted from the journal (Sürücü & Maslakçi, 2020). The calculation result from the reliability test states that the score of Cronbach's Alpha is 0.975. Data declared reliability if alpha value > 0, 7, based on calculation then the data is declared reliability.

3.2. Proposal analysis action corrective with the use of PICA table

Next corrective actions are made based on the ranking of prioritized RPN values to reduce level defects in production results. Based on Table 3 obtained the material that passes the control is a risk of failure with the lowest RPN value of 84. The highest RPN value of 484 is the factor causing the failure of the engine settings that are not appropriate. Corrective action was provided using PICA's top three rankings with the largest RPN value. Based on Table 3, the incoming RPN value to in three scores biggest is settings machine no appropriate, negligent in implementation production control and air pressure or water compressor that does not maximum or dead. Based on Table 5 can be seen corrective action table.

From Table 5 it is found that there are 3 causes of imperfect printing problems that is settings machine not appropriate, negligent implementation control production, and wind pressure or water compressor that does not maximum or dead which can be improved by increasing supervision and providing training good skills nor knowledge, that aim to maintain the condition of the engine and minimize defect. Corrective action that can be conducted is to do periodic WI retraining, inspect the conditioning machine regularly, do inspection periodically during the production process ongoing, evaluate results performance, and run a checksheet while

Table 4. Validity test table

Code	r- table	r- count	Note:	Code	r- table	r- count	Note:
V1	0.754	0.843	Valid	V15	0.754	0.821	Valid
V2	0.754	0.814	Valid	V16	0.754	0.809	Valid
V3	0.754	0,779	Valid	V17	0,754	0,844	Valid
V4	0,754	0,848	Valid	V18	0,754	0,814	Valid
V5	0,754	0,802	Valid	V19	0,754	0,787	Valid
V6	0,754	0,862	Valid	V20	0,754	0,891	Valid
V7	0,754	0,760	Valid	V21	0,754	0,771	Valid
V8	0,754	0,876	Valid	V22	0,754	0,888	Valid
V9	0,754	0,836	Valid	V23	0,754	0,859	Valid
V10	0,754	0,944	Valid	V24	0,754	0,830	Valid
V11	0,754	0,794	Valid	V25	0,754	0,898	Valid
V12	0,754	0,809	Valid	V26	0,754	0,813	Valid
V13	0,754	0,966	Valid	V27	0,754	0,847	Valid
V14	0,754	0,861	Valid				

Table 5. Corrective action based on the highest RPN value

No.	Problem	Repair	Why	How	When	Where	PIC
1.	Arrangement machine is not appropriate.	1. Boost supervision. 2. Giving training good skills or knowledge.	1. For guard condition machine. 2. Minimize disabled.	1. Do training repeat about IK _ periodically (per 1 month) for increase expertise and thoroughness. 2. Do inspection by regularly (per 1 week) regarding condition machine.	-	Machine Print.	Production Line.
2.	Negligent in implementation control production.	1. Boost supervision. 2. Giving training good skills or knowledge.	1. For minimize error work. 2. For minimize disabled.	1. Do evaluation performance. 2. Running checksheet during the production process in progress. 3. Make defective sample board as addition operator knowledge of type defects that customers often return.	-	Machine Print.	Production Line, QC/ QA.
3.	Pressure wind or water compressor that does not max / off.	1. Boost supervision. 2. Giving training good skills nor knowledge.	1. To keep the condition machine. 2. Minimize disabled.	Do inspection by periodically good before, when nor after production process.	-	Machine Print.	Maintenance, Production Line.

carrying out the production process. Corrective action has been done on the printing machine with the line division manager of Production, Maintenance, and QC/QA. Table 5 shows the corrective action table.

Analyzed PICA table then validated through interview. Results of analysis and interviews with management company explain that results of data processing and analysis FMEA is appropriate. The resulting interview could be said to be valid because fulfills the criteria.

4. CONCLUSIONS AND SUGGESTIONS

4.1. Conclusions

Based on the data obtained identified that the research conclusions are:

1. Processing results in SOD values found 3 rankings of the highest RPN values that is settings machine that is not appropriate with an RPN value of 484, negligent in process control production with the RPN value is 220, and the pressure wind or water compressor, not max / off with RPN value of 210.
2. Then analysis uses the PICA table to find corrective action which is to do periodic WI retraining, inspection of the conditioning machine regularly, inspection periodically during the production process ongoing, evaluate results performance, and run a check sheet while carrying out the production process.

4.2. Suggestions

This study has conducted an analysis using the failure mode effect analysis method. Further study can analyze the total losses resulting from defective products due to high return customers.

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