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Improving the Packaging Quality of Surgical Suture Products at PT. XYZ with the Application of the Six Sigma Method and Failure Mode Effect Analysis (FMEA)

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Abstract. The medical industry today upholds strict quality standards for medical products, including surgical sutures. PT XYZ, a leading manufacturer in this sector, faces challenges in mitigating surgical suture product defects. This research focuses on the packaging of surgical suture products produced by PT XYZ, with a focus on the production period from January to March. During this time period, there was a significant level of packaging production defects. The aim of future research is to improve the quality of packaging for surgical suture products. Specifically, it aims to identify the causes of defects in PT The Six Sigma method, using DMAIC, will be used in this research. The Define stage combines tools such as the Supplier, Input, Process, Output, and Customer (SIPOC) diagram, along with Critical to Quality (CTQ) identification. The Measure stage involves calculations using the P control chart, C control chart, DPMO, and sigma level. During the Analysis phase, a thorough analysis of the causes of failure is carried out using tools such as Pareto diagrams, fishbone diagrams, and Failure Mode Effects Analysis (FMEA). Moving to the Improve stage, FMEA identifies high-risk defects, including torn cartons, inconsistent colors, and damp cartons. Therefore, the proposed defect repair involves analysis of 5W 1H cartons. The results of the analysis provide alternative solutions such as increasing the frequency of replacing cutting tools on mold cutting machines, using cleaning aids on molding machines, and improving environmental monitoring SOPs in factories. An additional suggestion is to include antiseptic wet wipes in each carton of surgical suture products. After making improvements in the Improve stage, the final Control stage is carried out to assess the impact of the proposed changes on the company. The results show a positive impact, with an increase in the sigma value to 3.670.

1 Introduction

PT. XYZ is a manufacturing company that produces Surgical Sutures (surgical needles) in large quantities every day. Companies face high pressure to improve product quality due

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to increasing customer demands and industry competition. PT. XYZ implements a make-to-order production system to avoid wasting costs.

The company's main product is surgical suture, which is used in surgical procedures to suture cut or torn body tissue. There are several types of Surgical Suture products, with this research focusing on the Elvalene product. The company has a defect rate of 6%, including attribute and variable defects. Variable defects appear during the production process, while attribute defects are related to problems in the packaging process.

Even though there is process control, PT. XYZ has not achieved the desired quality target. Therefore, this research focuses on Elvalene product packaging with the aim of reducing the percentage of defects, improving product quality, and increasing customer trust.

One approach used is the Six Sigma method, which aims to minimize product variations and increase process capabilities [1]. The Six Sigma concept is used in the DMAIC (Define, Measure, Analyze, Improve, Control) cycle, with tools such as the Pareto Chart and Failure Mode and Effect Analysis (FMEA). The implementation of Six Sigma in the packaging process is expected to reduce the number of defective products produced, increase profits, and help companies achieve targeted quality standards.

The type of product that has the highest percentage of defects produced by the company is elvalene at 5.21%. The focus of this research focuses on the packaging of elvalene type products with the problems faced by companies that have not achieved the quality target for elvalene type surgical suture products. This type of elvalene product which is produced in large quantities has quite a large impact on defect results. Elvalene type products have 2 types of defects, namely defects in the needle attaching inspection process and defects in the packaging inspection process.

The company generalizes that the defect tolerance limit is 3%. From **Fig.1** it can be seen that the percentage of packaging defects is 4%, which means it is greater than needle attaching defects whose percentage is 2%. Therefore, improvements need to be made to the Elvalene product packaging process.

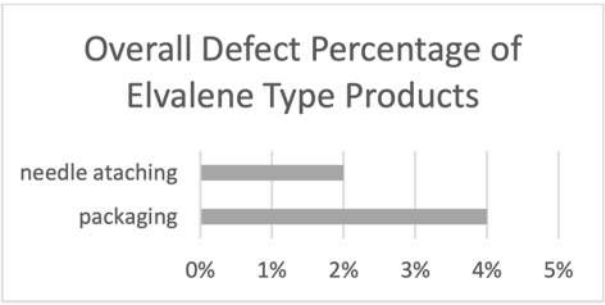


Fig. 1. Overall defect percentage of elvalene type products

2 Literature review

2.1 Define

In the Define stage, the first step is to identify the problem being faced to gain a deeper understanding of the problem being faced. In this process, tools such as the SIPOC diagram (Supplier, Input, Process, Output, Customer) are used to outline the main components in the process. Apart from that, this stage also involves the introduction of CTQ (Critical To Quality), namely factors that are key in maintaining product or service quality [2]. Identifying the problem and these critical elements is an important first step in ensuring that improvement efforts are aligned with organizational needs and customer satisfaction.

2.2 Measure

The next stage in DMAIC is the Measure stage, which involves analyzing the data that has been collected. In the context of this research, the use of control charts will be one of the main components of the Measure stage. Control charts are used to assess whether the process results are in a normal state or not, by referring to the values of UCL (Upper Control Limit), CL (Center Line), and LCL (Lower Control Limit) as control limits [3]. The data that has been analyzed will be represented in graphical form. At this Measure stage, calculations will also be carried out to determine the DPMO (Defects Per Million Opportunities) value and sigma level.

2.3 Analyze

The next step, namely the analyze stage, involves an in-depth analysis related to the root causes of failure in the production process [4]. In this analysis stage, various analysis tools are used, including Pareto diagrams, fishbone diagrams, and also analysis using the Failure Mode Effect Analysis (FMEA) method.

2.4 Improve

The next step is Improve, where changes will be implemented to improve process performance, and solutions will be developed to overcome the problems to be fixed [5].

2.5 Control

After implementing the recommendations for improvements that have been proposed, the next stage is the control stage, which aims to evaluate whether the solution implemented has a positive impact on the company.

3 Method

Fig. 2 show the research methodology flowchart.

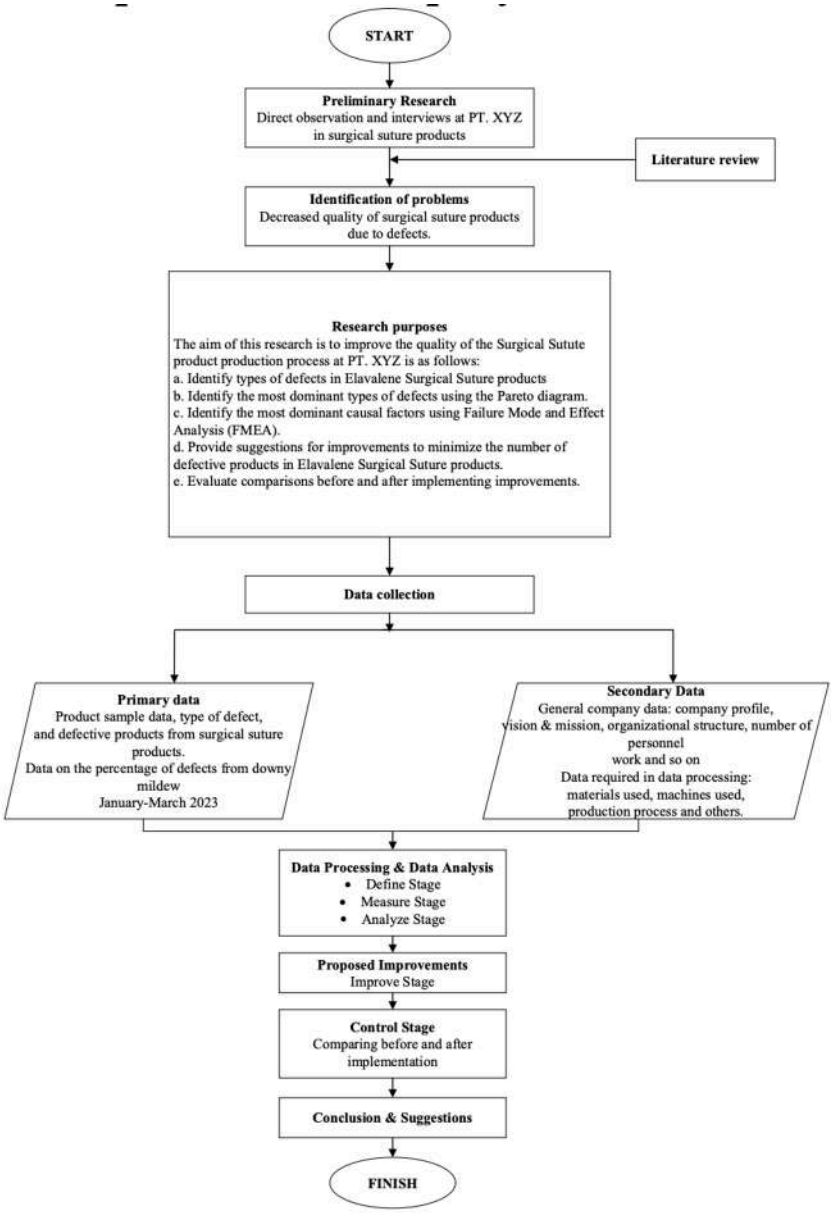


Fig. 2. Research methodology flowchart

4 Result

4.1 Define

The first step in the DMAIC method is the define stage which aims to identify opportunities for improvement in the quality of surgical suture products and their production processes. This stage includes the introduction of various aspects related to the product. Next, production and defect data are collected to identify key characteristics

in product quality (CTQ). The creation of SIPOC diagrams is used to describe in detail the production process and raw material flow, from raw material collection to the final product to the customer or warehouse.

PT XYZ has set quality standards for each product produced, with the aim of ensuring that these products can meet customer needs and preferences. The Critical To Quality (CTQ) identification process is used to recognize important aspects in the quality of surgical suture products that meet customer expectations [6]. CTQ identification is carried out by identifying the quality characteristics of the product that fall into the good category, as well as the quality characteristics that fall into the bad or defective category.

This quality standard is focused on the packaging process of elvalene surgical suture products set by the company and customer requests, which are as follow **Table 1**.

Table 1. The sipoc diagram

Supplier	Input	Process	Output	Customer
Korean & Chinese Vendors	Raw materials for spools of thread ± 500 m & Surgical needles	Delivery and receipt of raw materials to the warehouse	Incoming Raw Material Stock	Raw Material Warehouse
Raw Material Warehouse	Incoming Raw Material Stock	Raw material inspection	Spools of Yarn	Yarn Winding Place
Yarn Winding Place	Spools of Yarn	Unwinding	Results of spools of thread	Unwinding Machine
Winding Machine	Results of spools of thread	Cutting	Thread Piece 90 cm	Operator
Operator	Thread Piece 90 cm	Needle Attaching	Thread that has been connected to a needle	Operator
Operator	Thread that has been connected to a needle	Winding	thread & needle unit that has been inserted into in a plastic tray	Winding Machine
Winding Machine	thread & needle unit that has been inserted into in a plastic tray	Primary Packaging	Products that have been placed in aluminum foil	Operator
Operator	Products that have been placed in aluminum foil	Sterilization	Products that have been sterilized	EtO Machine
EtO Machine	Products that have been sterilized	Sealing & Blanking	Products that have aluminum foil installed	Sealing & Blanking Machine
Sealing & Blanking Machine	Products that have aluminum foil installed	Secondary Packaging	Products that have been put in cardboard	Packing place
Material Warehouse packaging place	Products that have been put in cardboard	Surgical suture product packaging process	Stack of surgical suture products	Finished Goods Warehouse

4.1.1 Torn cardboard

Surgical suture packaging cardboard should not be torn. Torn product cardboard defects are damage to the product packaging that results in holes or tears in the cardboard. Some common physical features of this defect are tears in cardboard, usually seen in the form of tears, namely parts of the cardboard that are separated or torn apart. Tears can be small or large, depending on the cause and extent of the damage. Torn defects can be in the form of holes or holes in the cardboard. These holes can be small or large, and they can result in damage to the product inside if not properly addressed.

4.1.2 Print error

The molded parts of the surgical suture packaging cardboard should not experience printing errors. Misprinted product packaging cardboard defects are a type of defect that occurs when the printing process on the cardboard used to package the product produces an error or the print does not match the desired design. These defects can involve a variety of printing issues, such as Incorrect Insertion of Text on a print can result in incorrect text, or even text that is completely different than what should be on the packaging. The wrong print position is the print that is not in the correct position on the cardboard, so that the desired image or text does not match the desired position.

4.1.3 Color does not match

There should be no elavelene surgical suture packaging cardboard that has color nonuniformity. A defect in product packaging cardboard that is not uniform in color is a type of defect that occurs when the cardboard used to package the product has striking differences in color or appearance between different parts of the cardboard. This color difference can occur on parts that should have a uniform color, such as the outer surface of the cardboard or the printing on the cardboard.

4.1.4 Damp cardboard

In surgical suture packaging cardboard, there should be no moisture absorption. Defects in cardboard packaging a damp product is a condition where the cardboard used to package the product absorbs or maintains high levels of moisture, in the form of the cardboard becoming soft or soft.

4.2 Measure

At this stage, measurements are taken to analyze existing problems using various tools, such as P and C attribute control maps, as well as evaluation of DPMO values and sigma levels.

4.2.1 P control map

The p control map is used to monitor the process based on the proportion of defects that are not in accordance with the standard specifications set by the company [8]. **Table 2** contains the calculation of the p control map used to assess the proportion of defects based on observation data during February-March of 2023.

Table 2. Calculation of P control map

Day	Date	Number of Production Samples (Pcs)	Number of Defective Products (Pcs)	Proportion of Defective Products	CL	UCL	LCL
1	13-Feb	35	3	0,08571	0,1143	0,2756	-0,437
2	14-Feb	35	2	0,05714	0,1143	0,2756	-0,561
3	15-Feb	35	3	0,08571	0,1143	0,2756	-0,437
4	16-Feb	35	4	0,11429	0,1143	0,2756	-0,363
5	17-Feb	35	6	0,17143	0,1143	0,2756	-0,275
6	20-Feb	35	3	0,08571	0,1143	0,2756	-0,437
7	21-Feb	35	3	0,08571	0,1143	0,2756	-0,437
8	22-Feb	35	6	0,17143	0,1143	0,2756	-0,275
9	23-Feb	35	2	0,05714	0,1143	0,2756	-0,561
10	24-Feb	35	5	0,14286	0,1143	0,2756	-0,313
11	27-Feb	35	5	0,14286	0,1143	0,2756	-0,313
12	28-Feb	35	5	0,14286	0,1143	0,2756	-0,313
13	01-Mar	35	6	0,17143	0,1143	0,2756	-0,275
14	02-Mar	35	5	0,14286	0,1143	0,2756	-0,313
15	03-Mar	35	4	0,11429	0,1143	0,2756	-0,363
16	06-Mar	35	3	0,08571	0,1143	0,2756	-0,437
17	07-Mar	35	2	0,05714	0,1143	0,2756	-0,561
18	08-Mar	35	5	0,14286	0,1143	0,2756	-0,313
19	09-Mar	35	3	0,08571	0,1143	0,2756	-0,437
20	10-Mar	35	5	0,14286	0,1143	0,2756	-0,313

$$CL = \bar{p} = \frac{\sum p}{inspection\ total} = \frac{80}{700} = 0.2286 \quad (1)$$

$$UCL = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{35}} = 0.2286 + 3\sqrt{\frac{0.2286(1-0.2286)}{35}} = 0.4415 \quad (2)$$

$$LCL = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{35}} = 0.2286 - 3\sqrt{\frac{0.2286(1-0.2286)}{35}} = 0.0156 \quad (3)$$

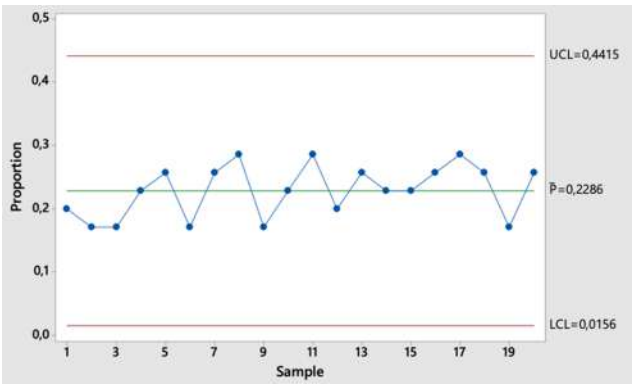


Fig. 3. Plot of P control map data

From the results of calculations and data plots (**Fig. 3**), it can be concluded that the data can be considered under control or within the control range, so the next step is to calculate the DPMO value and sigma level.

4.2.2 Control map C

The C control map is used to monitor the number of defects that appear in the product produced, not the defective product itself [8]. **Table 3** is the result of the calculation of the C control map used to record the number of these defects.

Table 3. Calculation of C control map

Day	Date	Number of Production Samples (Pcs)	Number of Defective Products (Pcs)	Proportion of Defective Products	CL	UCL
1	13-Feb	35	7	8	16,485	0
2	14-Feb	35	6	8	16,485	0
3	15-Feb	35	6	8	16,485	0
4	16-Feb	35	8	8	16,485	0
5	17-Feb	35	9	8	16,485	0
6	20-Feb	35	6	8	16,485	0
7	21-Feb	35	9	8	16,485	0
8	22-Feb	35	10	8	16,485	0
9	23-Feb	35	6	8	16,485	0
10	24-Feb	35	8	8	16,485	0
11	27-Feb	35	10	8	16,485	0
12	28-Feb	35	7	8	16,485	0
13	01-Mar	35	9	8	16,485	0
14	02-Mar	35	8	8	16,485	0
15	03-Mar	35	8	8	16,485	0
16	06-Mar	35	9	8	16,485	0
17	07-Mar	35	10	8	16,485	0
18	08-Mar	35	9	8	16,485	0
19	09-Mar	35	6	8	16,485	0
20	10-Mar	35	9	8	16,485	0
TOTAL		700	160			

$$CL = \bar{c} = \frac{\sum c}{\sum k} = \frac{160}{20} = 8 \quad (4)$$

$$UCL = \bar{c} + 3\sqrt{\bar{c}} = 8 + 3\sqrt{8} = 0.16485 \quad (5)$$

$$LCL = \bar{c} - 3\sqrt{\bar{c}} = 8 - 3\sqrt{8} = 0.485 \approx 0 \quad (6)$$

The results of calculations and data plots (**Fig. 4**) show that the data can be said to be in control or already within the control limits so that it can be continued to calculate the DPMO value and sigma level.

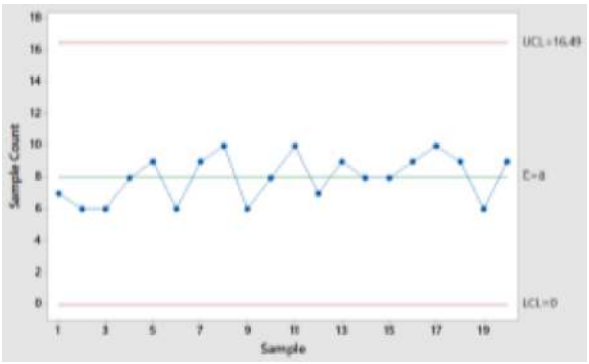


Fig. 4. Plot of C control map data

4.2.3 Calculation of DPMO and sigma level

Based on the calculation of the control map, the calculation of DPMO & Sigma Level is then carried out.

$$DPU = \frac{defect}{unit} = \frac{160}{700} = 0.2286 \quad (7)$$

$$DPO = \frac{defect}{unit\ x\ opportunity} = \frac{120}{700\ x\ 4} = 0.042857 \quad (8)$$

$$DPMO = DPO\ x\ 1{,}000{,}000 = 0.042857\ x\ 1{,}000{,}000 = 42.857 \quad (9)$$

$$Sigma\ level = normsinv\left(1 - \frac{DPMO}{1{,}000{,}000}\right) + 1.5 = normsinv\left(1 - \frac{42.857}{1{,}000{,}000}\right) + 1.5 = 3.218 \quad (10)$$

4.3 Analyze

4.3.1 Pareto diagram

Pareto diagrams are used to determine the most dominant defects of a product [9]. This stage analyzes and identifies the causes of defects from each production process. Based on the results of observations, there are types of defects in surgical suture packaging products. To identify the most dominant defects, a pareto diagram with the 80:20 principle was used. This principle indicates that 80% of defects are caused by 20% of the causes. Based on the **Fig. 5**, the defects with the highest frequency are torn cardboard, inconsistent color on the packaging and damp cardboard. They reach 56.3% 21.9% and 15.6% respectively. Therefore, it can be concluded that the priority for analyzing the causal factors of defects is on these three types of defects.

After getting the most dominant types of defects, namely torn cardboard, inappropriate color and moisture, an analysis of the causes of the dominant defects is carried out using the Ishikawa diagram.

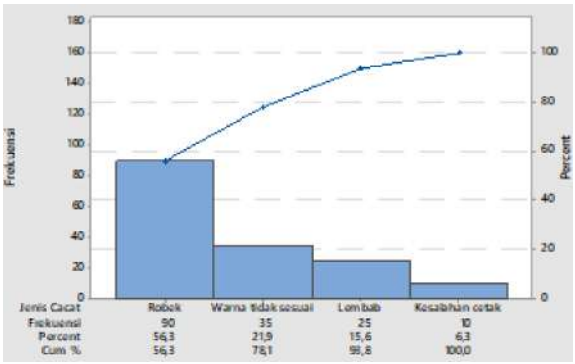


Fig. 5. Pareto diagram of defect types

4.3.2 Ishikawa diagram

The Ishikawa diagram, also known as a fishbone diagram, is a tool that has similarities to the shape of a fishbone [10]. This diagram is used to illustrate the relationship between the causes and effects of a problem at hand. In the Ishikawa diagram, there are five factors known as the cause of an effect, namely man, machine, method, material, and environment. Below, there is an example of an Ishikawa diagram that illustrates the causal factors that play the most role in the types of defects that dominate, namely torn cardboard, inconsistent colors on packaging and cardboard units as shown in **Fig. 6** to **Fig. 8**.

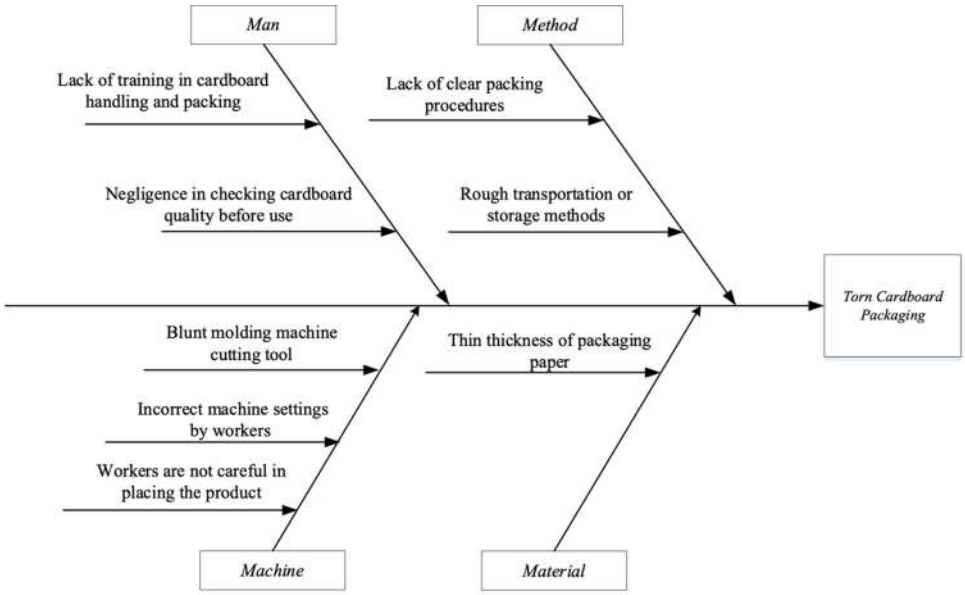


Fig. 6. Fishbone diagram of types of cardboard packaging defects

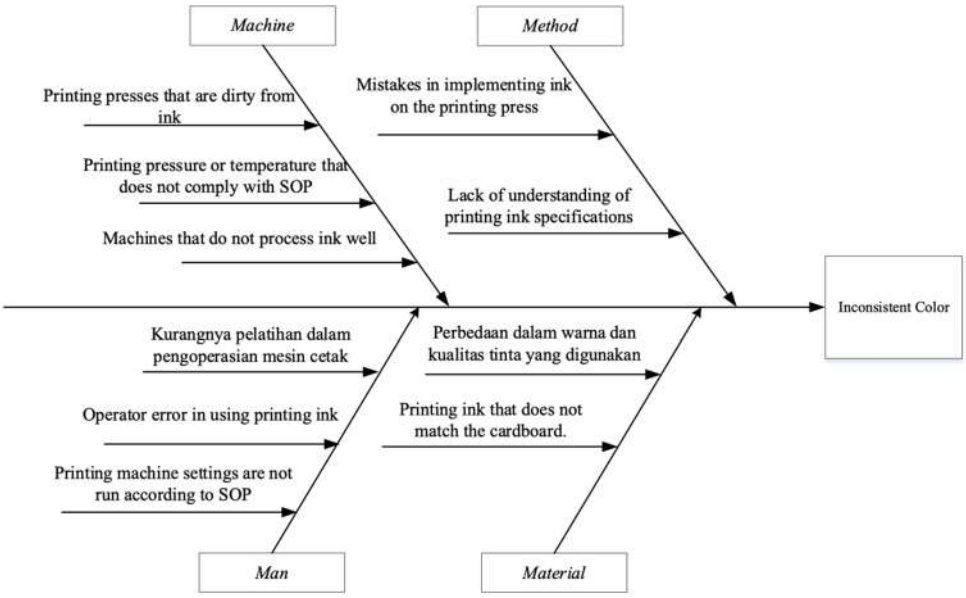


Fig. 7. Fishbone diagram of defect type inconsistent color

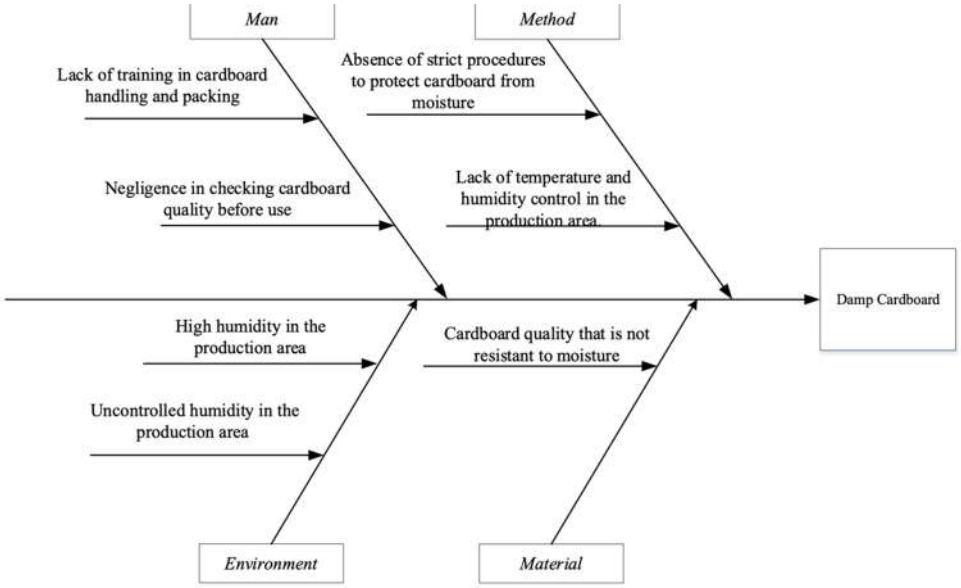


Fig. 8. Fishbone diagram of types of damp defects

4.3.3 Failure mode effect analysis (FMEA)

Failure Mode Effect Analysis (FMEA) is a method used to improve safety in the process by identifying and preventing potential failures or errors that can occur during the production process [11]. There are three parameters used in FMEA calculations, namely severity, occurrence, and detectability. From these three parameters, the RPN (Risk Priority Number) value is obtained, where the highest RPN value is a priority in making

improvements. **Table 4** contains the results of FMEA calculations with RPN values obtained through interviews.

Table 4. Calculation of failure mode effect analysis value

Process	Type of failure	Effects Arising from Failure	Causes of Process Failure	Controls that have been carried out	D	RPN
Packaging process	Torn Cardboard	Loss of Product Value and Lack of Protection	Operators are not careful in assembling the product	Review the methods used to move raw materials or products	5	245
			Rough methods of transportation or storage		5	210
			Blunt printing machine cutting tool	Replace cutting tools once every 2 weeks	6	336
	Inconsistent Colors	Declining Brand Image and Lack of Uniformity in the Market	Ink quality varies within each batch	Check ink raw materials according to SOP provisions	5	245
			Lack of clear procedures to achieve color consistency		5	175
			The machine is dirty due to ink sticking to the printing machine	Cleaning once a week	5	280
	Moist	Decreased Durability of Cardboard	Production or storage devices that are not protected from moisture	Check room temperature suitability	6	210
			Lack of temperature and humidity control in production areas		6	252
			The absence of strict procedures to protect cardboard from moisture		5	245
	Print Error	Product Identification and Information Errors	Differences in color and quality of ink used	Regular inspection and supervision of operator performance (every 2 weeks)	5	210
			Printing ink that does not match the cardboard		5	245
			Lack of training in printing machine operation		5	175

After identifying potential failures using FMEA, there are 12 causes of failure that occur with RPN values that have been calculated with the values of S, O, and D. Potential failures that are prioritized in making improvements are those with the highest RPN values. From the FMEA results, the failure of torn cardboard with the cause of the cutting tool on the blunt mold cutting machine has the highest RPN value of 336. As for the type of failure, the color is inconsistent with the cause because the printing machine is dirty due to the ink attached to the printing machine and has an RPN value of 280. And for the failure of damp cardboard with the cause of the lack of temperature and humidity control in the production area which has an RPN value of 252. This cause will be the focus of the proposed improvements.

4.3.4 5W 1H

The 5W 1H method is an approach or framework used to detail and better understand an event or problem [11]. This 5W+1H method is very useful because it helps identify and detail important information needed for a better understanding of a particular situation. This method was carried out after knowing the two largest RPNs from the Failure Mode and Effect Analysis (FMEA) method, namely the type of torn cardboard defect with the cause of the operator being less careful in placing the product and the type of print error

defect with the cause of the printing machine settings not being carried out according to company directions.

4.4 Improve

The Improve stage is the step after the Analyze stage in improving the quality of surgical suture products. The goal is to propose improvements that can reduce product defect rates and increase product sigma levels [12]. Proposed improvements are made based on the identification of potential causes of failure using tools such as Pareto Diagrams, p and c Control Maps, Fishbone Diagrams, FMEA, and 5W 1H (**Table 5**), which have been used previously in the Define, Measure, and Analyze stages. These proposed improvements were generated through a brainstorming session with Ms. Keithy, head of QC staff, with the hope that the planned improvements would improve product quality and reduce defects in surgical suture products. The list of proposed improvements can be found in Table 6.

Table 5. 5W 1H Analysis

Factor	Blunt printing machine cutting tool	Dirty printing machine	Lack of temperature and humidity control in production areas
What	Printing machine cutting tools are blunt due to cutting with a capacity of 300 pcs	The operator did not clean the printing machine Routinely	Temperature control in production areas is not monitored properly and there is a lack of regular checks
Why	So that the printing machine's cutting tools are not blunt, thereby reducing defects in torn cardboard	So that operators clean the printing machine so that they can reduce inconsistent color defects	So that temperature and humidity are controlled thereby reducing defects in torn cardboard
Where	At the production site, packaging section	At the production site, print packaging section	In the factory temperature, humidity and pressure monitoring room
When	Before starting the shift	Before starting the shift	Before starting the shift
Who	Production operator	Production operator	Staff Engineering
How	Reducing the cutting capacity of cardboard molds to 150 pcs and checking forms as a control tool	Remind the operator to carry out cleaning with the tool and also with the form as a control tool	Improved the factory environmental monitoring sop and added a factory environmental monitoring data analysis results worksheet

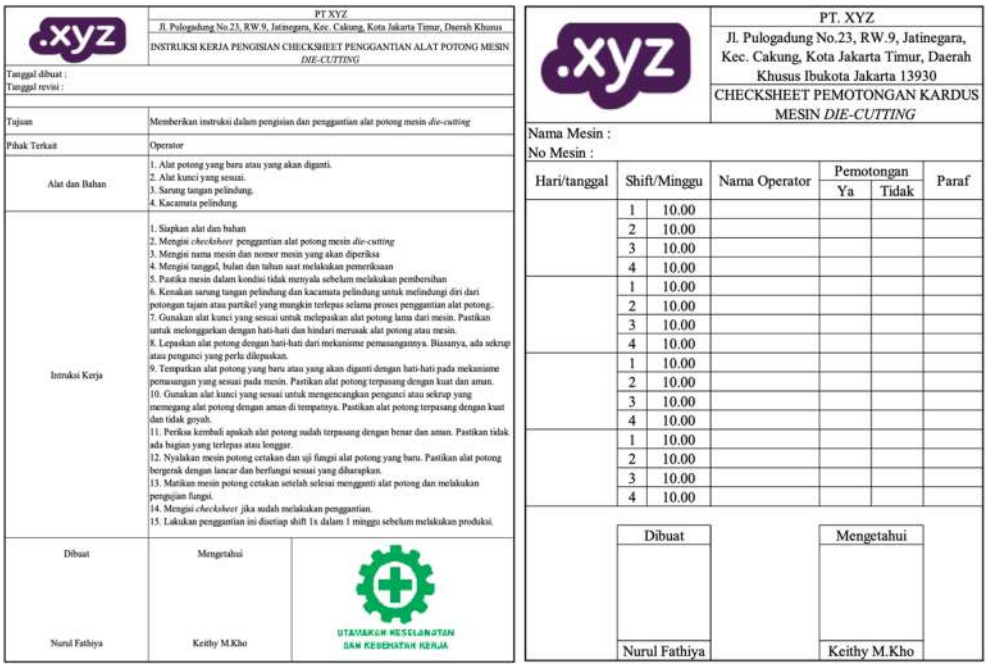
Table 6. Proposed improvements

No	Failure	Causes of failure	Proposed improvements
1	Shredded Cardboard	Blunt printing machine cutting tools	Reduced the cutting capacity of cardboard molds from 300 Pcs to 150 Pcs
			Reducing the cutting capacity of cardboard molds to 150 Pcs using the form as a control tool
2	Inconsistent colors	Dirty printing machine	Cleaning aids and cleaning fluids
			Perform daily machine cleaning using the form as a control tool
3	Humid	Lack of temperature and humidity control in the production area	Improve SOPs for Factory Environmental Monitoring
			Adding a Worksheet on the Results of Factory Environment Management Data Analysis as a control tool

4.4.1 Proposed increase in frequency of cutting tool replacement

The company uses a Die-cutting machine to cut the printed cardboard patterns. This machine is used to cut various types of materials into the desired shape with the help of a special mold called a "die". Die-cutting machine operators are responsible for setting up the machine, replacing the die if needed, and monitoring the quality of the products produced.

After analysis through the 5W 1H table, it was found that the cause of the torn cardboard defect was due to the blunt cutting tool of the die-cutting machine. This is due to the infrequent replacement frequency of the cutting tools, which resulted in torn surgical suture cardboard products. Therefore, the proposed improvement is to increase the frequency of cutting tool replacement from 2 weeks 1x to 1 week 1x, with necessary supervision and check sheet revision. This has been discussed with the person in charge of production and implemented in the revised work instruction (**Fig. 9**) with cutting tool changeover performed every time before starting the shift. The aim is to reduce the incidence of defects in torn cardboard products in the future.



PT XYZ
Jl. Pulogadung No.23, RW.9, Jatinegara, Kec. Cakung, Kota Jakarta Timur, Daerah Khusus
INSTRUKSI KERJA PENGISIAN CHECKSHEET PENGGANTIAN ALAT POTONG MESIN *DIE-CUTTING*

Tanggal dibuat :
Tanggal revisi :

Tujuan	Memberikan instruksi dalam pengisian dan penggantian alat potong mesin *die-cutting*
Pihak Terkait	Operator
Alat dan Bahan	1. Alat potong yang baru atau yang akan diganti. 2. Alat kunci yang sesuai. 3. Sarung tangan pelindung. 4. Kacamata pelindung.
Intruksi Kerja	1. Siapkan alat dan bahan 2. Mengisi *checksheet* penggantian alat potong mesin *die-cutting* 3. Mengisi nama mesin dan nomor mesin yang akan diperiksa 4. Mengisi tanggal, bulan dan tahun saat melakukan pemeriksaan 5. Pastika mesin dalam kondisi tidak menyala sebelum melakukan pembersihan 6. Kenakan sarung tangan pelindung dan kacamata pelindung untuk melindungi diri dari potongan tajam atau partikel yang mungkin terlepas selama proses penggantian alat potong. 7. Gunakan alat kunci yang sesuai untuk melepaskan alat potong lama dari mesin. Pastikan untuk melonggarkan dengan hati-hati dan hindari merusak alat potong atau mesin. 8. Lepaskan alat potong dengan hati-hati dari mekanisme pemasangannya. Biasanya, ada sekrup atau pengunci yang perlu dilepaskan. 9. Tempatkan alat potong yang baru atau yang akan diganti dengan hati-hati pada mekanisme pemasangan yang sesuai pada mesin. Pastikan alat potong terpasang dengan kuat dan aman. 10. Gunakan alat kunci yang sesuai untuk mengencangkan pengunci atau sekrup yang memegang alat potong dengan aman di tempatnya. Pastikan alat potong terpasang dengan kuat dan tidak goyah. 11. Periksa kembali apakah alat potong sudah terpasang dengan benar dan aman. Pastikan tidak ada bagian yang terlepas atau longgar. 12. Nyalakan mesin potong cetakan dan uji fungsi alat potong yang baru. Pastikan alat potong bergerak dengan lancar dan berfungsi sesuai yang diharapkan. 13. Matikan mesin potong cetakan setelah selesai mengganti alat potong dan melakukan pengujian fungsi. 14. Mengisi *checksheet* jika sudah melakukan penggantian. 15. Lakukan penggantian ini disetiap shift 1x dalam 1 minggu sebelum melakukan produksi.

Dibuat	Mengetahui	
Nurul Fathiya	Keithy M.Kho	UTAMAKAN KESELAMATAN DAN KESEHATAN KERJA

PT. XYZ
Jl. Pulogadung No.23, RW.9, Jatinegara, Kec. Cakung, Kota Jakarta Timur, Daerah Khusus Ibukota Jakarta 13930
CHECKSHEET PEMOTONGAN KARDUS MESIN *DIE-CUTTING*

Nama Mesin :
No Mesin :

Hari/tanggal	Shift/Minggu		Nama Operator	Pemotongan		Paraf
				Ya	Tidak	
	1	10.00				
	2	10.00				
	3	10.00				
	4	10.00				
	1	10.00				
	2	10.00				
	3	10.00				
	4	10.00				
	1	10.00				
	2	10.00				
	3	10.00				
	4	10.00				
	1	10.00				
	2	10.00				
	3	10.00				
	4	10.00				

Dibuat	Mengetahui
Nurul Fathiya	Keithy M.Kho

Fig. 9. Work instruction for check sheet filling and die-cutting tool replacement

4.4.2 Proposed use of printing press cleaning aids

Printing presses are industry-specific equipment used to print various types of packaging. The company uses a Ranger Type XP600 indoor digital printing machine to print surgical suture product packaging. It is important to choose a printing machine that suits the production needs to maintain quality and efficiency. Inconsistent color defects in cardboard are caused by ink impurities on the printing machine. Therefore, the use of a

molding machine cleaning tool is proposed as a solution. This proposal came about because the company did not have effective equipment to clean the molding machine. Trials were conducted to select suitable cleaning equipment and fluids based on the criteria of price, cleaning time, and finish.

After trials, the decision was made to use chamois and solvent cleaner as cleaning tools that were more economical, time-efficient, and effective in keeping the print screen clean and protected. This decision was based on the affordable price, faster cleaning process, and the chamois' ability to absorb ink well compared to a rag. The chamois used has dimensions of 32 cm × 20 cm, weighs about 30 grams per sheet, and is made from the main raw material of microfiber. Solvent cleaner was chosen as the cleaning fluid because it is safe to remove ink without damaging the printing press. Fig. 10 illustrate the chamois and solvent cleaner.

Fig. 10. Chamois and solvent cleaner

Based on the results of the FMEA analysis, the cardboard color defect is not suitable because the printing machine is dirty. The cleaning of the molding machine that the company has been doing is done once a day with no routine after finishing production. But from the observation, there is dirt and dust on the machine and also the results of printing are not according to the desired standard. So, there is a need for routine cleaning. The proposal for routine cleaning was discussed with the person in charge of production to be 3 times a day which is done at the end of each shift or before the break begins. This routine cleaning is then controlled by making existing check sheets and making work instructions which can be seen in Fig. 11.

4.4.3 Proposed improvements to the factory environmental monitoring SOPs

The Factory Environmental Monitoring Standard Operating Procedure (SOP) is a document that details steps and guidelines for factory staff in monitoring and controlling environmental conditions. This SOP aims to ensure compliance with environmental regulations, maintain sustainability, and prevent negative impacts on the surrounding environment. One aspect of improvement in the SOP is the identification and control of potential moisture sources in the factory, such as leaking pipes or leaking roofs, to prevent product damage. In addition, companies use Operational Management Systems (OOS) and Energy Management Systems (EMS) to efficiently regulate temperature and maintain appropriate temperature conditions in their facilities. An Operational Management System (OOS) is a system designed to monitor, control and optimize various operations

within a facility, including temperature regulation. OOS aims to improve operational efficiency, reduce costs, and maintain the comfort and safety of facility users. In terms of temperature regulation, OOS can manage HVAC systems to maintain a comfortable temperature and avoid wasting energy. Meanwhile, Energy Management Systems (EMS) focus more on optimizing energy use in facilities, including temperature regulation. EMS involves monitoring and controlling devices such as heaters, air conditioners, pumps, and others to improve energy efficiency with the aim of reducing energy consumption and costs, but still maintaining the temperature as needed. After analysis through the 5W 1H table, it was identified that the cause of the damp cardboard defect was the lack of temperature and humidity control in the production area due to the lack of organization in managing temperature by the engineering staff. Humidity is a risk factor for damage to cardboard packaging. Updating the SOP is the solution to identify more preventive measures effective in reducing the risk of cardboard becoming damp and deformed during production and storage.

.xyz	PT XYZ Jl. Pulogadung No.23, RW.9, Jatinegara, Kec. Cakung, Kota Jakarta Timur, Daerah Khusus Ibukota Jakarta 13930 INSTRUKSI KERJA PENGISIAN CHECKSHEET PEMBERSIHAN MESIN CETAKAN	
Tanggal dibuat : Tanggal revisi :		
Tujuan	Memberikan instruksi dalam pengisian dan pembersihan mesin cetakan kardus packaging	
Pihak Terkait	Operator	
Alat dan Bahan	1. Sarung Tangan Karet 2. Kanebo 3. Cairan solvent clenaer	
Intruksi Kerja	1. Siapkan alat dan bahan 2. Mengisi *checksheet* pembersihan mesin cetakan 3. Mengisi nama mesin dan nomor mesin yang akan diperiksa 4. Mengisi tanggal, bulan dan tahun saat melakukan pemeriksaan 5. Pastika mesin dalam kondisi tidak menyala sebelum melakukan pembersihan 6. Angkat penutup mesin cetakan sehingga ada jarak antara penutup dan mesin cetakan 7. Bersihkan mesin cetakan dari sisa-sisa tinta hasil *printing* dan kotoran yang menempel pada mesin dengan kanebo dan larutan *solvent cleaner* 8. Periksa kembali apakah mesin cetakan sudah bersih dan tunggu 15 detik sampai larutan mengering 9. Mengisi *checksheet* jika sudah melakukan pembersihan 10. Lakukan pembersihan ini disetiap shift setelah selesai melakukan produksi.	
Dibuat Nurul Fathiya	Mengetahui Keithy M.Kho	UTAMAKAN KESELAMATAN DAN KESEHATAN KERJA

.xyz			PT. XYZ Jl. Pulogadung No.23, RW.9, Jatinegara, Kec. Cakung, Kota Jakarta Timur, Daerah Khusus Ibukota Jakarta 13930 CHECKSHEET PEMBERSIHAN MESIN CETAKAN			
Nama Mesin : No Mesin :						
Hari/tanggal	Shift/Jam		Nama Operator	Pembersihan		Paraf
				Ya	Tidak	
	1	10.00				
	2	12.00				
	3	16.00				
	1	10.00				
	2	12.00				
	3	16.00				
	1	10.00				
	2	12.00				
	3	16.00				
	1	10.00				
	2	12.00				
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	3	16.00				
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	2	12.00				
	3	16.00				
	1	10.00				
	2	12.00				
	3	16.00				
	Dibuat Nurul Fathiya			Mengetahui Keithy M.Kho		

Fig. 11. Work instruction for check sheet filling and cleaning molding machine

Engineering staff who are less familiar with EMS and OOS need more detailed explanations to understand their potential and benefits. Improving the SOPs with more detailed explanations will improve their understanding of how these systems work and the benefits that can be gained. With a better understanding of the use of EMS and OOS, engineering staff can more effectively optimize energy use and facility operations, which can reduce the risk of damp cardboard due to inappropriate temperatures. Proposed improvements to the factory's environmental monitoring SOPs were discussed with the

person in charge of production and overseen by the creation of OOS and EMS data sheets and EMS & OOS data analysis results worksheets documented in **Fig. 12** and **Fig. 13**.

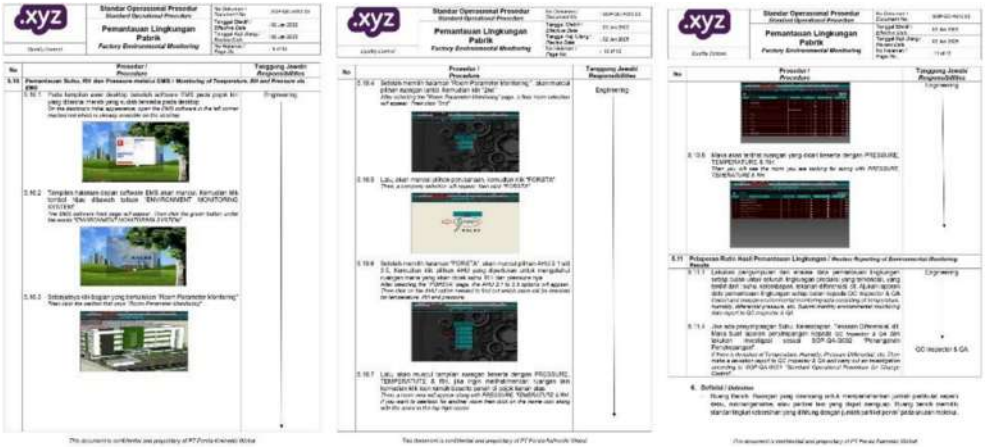

Fig. 12. Improvement of factory environmental monitoring SOP

Fig. 13. EMS OOS data analysis result worksheet

4.4.4 Proposed additional antiseptic wet wipes on each cardboard package

The addition of antiseptic wet wipes in each cardboard package of surgical suture products because antiseptic wet wipes play an important role in maintaining hygiene (**Fig. 14**). In the context of surgical procedures, maintaining the area around the wound or incision prior to suture application is essential to prevent infection. Antiseptic wet wipes can effectively clean and help eliminate potentially harmful microorganisms. Furthermore, the addition of antiseptic wet wipes also strengthens the sterilization aspect of the product. As surgical sutures need to remain sterile before being used on patients, antiseptic wet wipes included in the packaging can help ensure that the product remains sterile during storage and transportation. This is a key step in meeting the safety and quality standards required in the medical field.

Fig. 14. Antiseptic/alcohol cotton

The healthcare professional caring for the patient will have easy access to the antiseptic cleaning tools required to carry out the procedure correctly. This can save time and ensure that every necessary step can be performed well before the use of surgical sutures. Furthermore, the addition of antiseptic wet wipes also reduces the risk of infection. By cleaning the wound or incision area before using surgical sutures, the risk of contamination can be minimized. This is crucial in the quest to achieve optimal surgical outcomes and maintain patient well-being. The addition of antiseptic wet wipes to cardboard packaging is a step that has significant benefits in maintaining hygiene, sterilization, ease of use, reduction of infection risk, and patient safety in the context of surgical care.

4.5 Control

The Control phase is the last step applied in the six-sigma methodology. In this phase, the implementation of improvement suggestions has been carried out in accordance with the suggestions that have been designed at the Improvement stage. Of the 6 improvement suggestions that have been formulated, there is one suggestion that cannot be implemented in this study (**Table 7**). This situation occurs due to time constraints in the implementation of improvement suggestions.

Table 7. Implementation of proposed improvements

No	Failure	Causes of failure	Proposed improvements	Implementation
1	Shredded Cardboard	Blunt printing machine cutting tools	Reducing the frequency of long replacement of printing machine cutting tools from 1x in 2 weeks to 1x in 1 week	Yes
			Replace the cutting tools of the printing machine every 1 week 1x by using the form as a control tool	Yes
2	Inconsistent colors	Dirty printing machine	Cleaning aids and cleaning fluids	No
			Perform daily machine cleaning using the form as a control tool	Yes
3	Humid	Lack of temperature and humidity control in the production area	Improve SOPs for Factory Environmental Monitoring	Yes
			Adding a Worksheet on the Results of Factory Environment Management Data Analysis as a control tool	Yes

4.5.1 Calculation of control map after implementation

The calculation of the p control map is carried out using product defect data at the time of implementation for 15 days, with 35 samples taken every day (**Table 8**).

Table 8. P control map calculation

Day	Date	Number of Production Samples (Pcs)	Number of Defective Products (Pcs)	Proportion of Defective Products	CL	UCL	Day
1	13-Feb	35	2	0,0571429	0,1142857	0,2756	-0,561
2	14-Feb	35	1	0,0285714	0,1142857	0,2756	-0,84
3	15-Feb	35	2	0,0571429	0,1142857	0,2756	-0,561
4	16-Feb	35	3	0,0857143	0,1142857	0,2756	-0,437
5	17-Feb	35	3	0,0857143	0,1142857	0,2756	-0,437
6	20-Feb	35	1	0,0285714	0,1142857	0,2756	-0,84
7	21-Feb	35	2	0,0571429	0,1142857	0,2756	-0,561
8	22-Feb	35	3	0,0857143	0,1142857	0,2756	-0,437
9	23-Feb	35	1	0,0285714	0,1142857	0,2756	-0,84
10	24-Feb	35	3	0,0857143	0,1142857	0,2756	-0,437
11	27-Feb	35	1	0,0285714	0,1142857	0,2756	-0,84
12	28-Feb	35	3	0,0857143	0,1142857	0,2756	-0,437
13	01-Mar	35	3	0,0857143	0,1142857	0,2756	-0,437
14	02-Mar	35	1	0,0285714	0,1142857	0,2756	-0,84
15	03-Mar	35	1	0,0285714	0,1142857	0,2756	-0,84
TOTAL		525	30				

$$CL = 0.571 \tag{11}$$

$$UCL = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{35}} = 0.571 + 3\sqrt{\frac{0.571(1-0.571)}{35}} = 0.1748 \tag{12}$$

$$LCL = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{35}} = 0.571 - 3\sqrt{\frac{0.571(1-0.571)}{35}} = 0 \tag{13}$$

4.5.2 Calculation of control map

After Implementation The calculation of the C control map is carried out using product defect data at the time of implementation for 15 days, with 35 samples taken every day (**Table 9**).

Table 9. C control map calculation

Day	Date	Number of Production Samples (Pcs)	Number of Defective Products (Pcs)	Proportion of Defective Products	CL	UCL
1	05-Okt	35	3	8	16,485	0
2	06-Okt	35	1	8	16,485	0
3	09-Okt	35	3	8	16,485	0
4	10-Okt	35	3	8	16,485	0
5	11-Okt	35	2	8	16,485	0
6	12-Okt	35	3	8	16,485	0

Day	Date	Number of Production Samples (Pcs)	Number of Defective Products (Pcs)	Proportion of Defective Products	CL	UCL
7	13-Okt	35	3	8	16,485	0
8	16-Okt	35	2	8	16,485	0
9	17-Okt	35	3	8	16,485	0
10	18-Okt	35	1	8	16,485	0
11	19-Okt	35	2	8	16,485	0
12	20-Okt	35	3	8	16,485	0
13	23-Okt	35	1	8	16,485	0
14	24-Okt	35	3	8	16,485	0
15	25-Okt	35	2	8	16,485	0
TOTAL		525	35			

$$CL = 2.33 \quad (14)$$

$$UCL = \bar{c} + 3\sqrt{\bar{c}} = 8 + 3\sqrt{8} = 6.916 \quad (15)$$

$$LCL = \bar{c} - 3\sqrt{\bar{c}} = 8 - 3\sqrt{8} = 0 \quad (16)$$

4.5.3 Calculation of DPMO and sigma level

After Implementation Calculation of the Defects per Million Opportunities (DPMO) value and sigma level after implementation is done after the control map calculation is complete (Table 10). The DPMO value and sigma level obtained will then be compared with the DPMO value and sigma level before implementation, by calculating the DPU value and DPO value first:

- The number of defects in production results after implementation is 35.
- The number of units or samples used in research after implementation is 525.
- The number of opportunities or opportunities for defects of 4, namely torn cardboard, printing errors, inconsistent colors and moisture.

$$DPU = \frac{defect}{unit} = \frac{35}{525} = 0.067 \quad (17)$$

$$DPO = \frac{defect}{unit\ x\ opportunity} = \frac{35}{525\ x\ 4} = 0.016 \quad (18)$$

$$DPMO = DPO\ x\ 1{,}000{,}000 = 0.016\ x\ 1{,}000{,}000 = 16{,}000 \quad (19)$$

$$Sigma\ level = normsinv\left(1 - \frac{DPMO}{1{,}000{,}000}\right) + 1.5 = normsinv\left(1 - \frac{16{,}000}{1{,}000{,}000}\right) + 1.5 = 3.670 \quad (20)$$

Table 10. Comparison of DPMO value and sigma level

Comparison	DPMO	Sigma Level
Before Implementation	42.900	3,195
After Implementation	16.000	3,67
Difference	26.900	0,475

5 Conclusion

The most common type of defect based on the Pareto diagram is a torn cardboard defect with a percentage of 59.9%. The two main causes of failure identified based on the highest RPN values are blunt mold cutting machines (RPN value 336) dirty printing machines

(RPN value 280) and lack of temperature and humidity control in the production area (RPN value 252). Some suggestions for improvement submitted to the company include Reducing the cutting capacity of cardboard molds, conducting regular cleaning with cleaning tools and improving the SOP for Factory Environmental Monitoring. After the implementation of the proposed improvements, there was a decrease in the DPMO value, from 42,900 to 16,000. The sigma level increased from 3.195 to 3.670. This shows that the company managed to reduce the number of defects without eliminating them completely, so that it can still meet customer satisfaction.

References

1. Mittal, P. Gupta, V. Kumar, A. Al Owad, S. Mahlawat, and S. Singh, "The performance improvement analysis using Six Sigma DMAIC methodology: A case study on Indian manufacturing company," Heliyon, vol. 9, no. 3, p. e14625, 2023, doi: 10.1016/j.heliyon.2023.e14625.
2. C. Sithole, I. Gibson, and S. Hoekstra, "ScienceDirect Evaluasi penerapan desain six sigma untuk teknologi manufaktur aditif logam," vol. 100, no. 2021, pp. 798–803, 2023.
3. A. Zhafira and R. Fitriana, "Quality Improvement and Waste Minimization in The Production Process of 450 MM Jacking Pipe Using the Lean Six Sigma Method," pp. 1069–1082, 2023, doi: 10.46254/ap03.20220211.
4. P. Fithri, "Six Sigma Sebagai Alat Pengendalian Mutu Pada Hasil Produksi Kain Mentah Pt Unitex, Tbk," J@ti Undip J. Tek. Ind., vol. 14, no. 1, p. 43, 2019, doi: 10.14710/jati.14.1.43-52.
5. A. Z. Al Faritsy and Angga Suluh Wahyunoto, "Analisis Pengendalian Kualitas Produk Meja Menggunakan Metode Six Sigma Pada PT XYZ," J. Rekayasa Ind., vol. 4, no. 2, pp. 52–62, 2022, doi: 10.37631/jri.v4i2.707.
6. E. Afriliano, S. T. S. L. A, and K. Kiswandono, "Analisis Pengendalian Kualitas untuk Mengurangi Kuantitas Kecacatan Produk (Studi Kasus pada Home Industry Tahu Jaya, Turen, Malang)," J. Mhs. Tek. Ind., vol. 4, no. 2, pp. 188–195, 2021.
7. Nailah, A. Harsono, and G. P. Liansari, "Usulan Perbaikan untuk Mengurangi Jumlah Cacat pada Produk Sandal Eiger S-101 Lightspeed dengan Menggunakan Metode Six Sigma," J. Online Inst. Teknol. Nas., vol. 2, no. 2, pp. 256–267, 2014.
8. D. Cesaron and Tandianto, "Penerapan Metode Six Sigma Dengan Pendekatan Dmaic Pada Proses Handling Painted Body Bmw X3 (Studi Kasus: Pt. Tjahja Sakti Motor)," J. PASTI, vol. IX, no. 3, pp. 248–256, 2019.
9. I. Mayusda, "Quality Improvement of Tin Ingot Product Using Six Sigma Method at PT Timah Tbk," Opsi, vol. 16, no. 1, p. 121, 2023, doi: 10.31315/opsi.v16i1.7434.
10. A. Bakhtiar, B. R. Dzakwan, M. E. Br Sipayung, and C. A. Pradhana, "Penerapan Metode Six Sigma di PT Triangle Motorindo," Opsi, vol. 13, no. 2, p. 113, 2020, doi: 10.31315/opsi.v13i2.4066.
11. H. Sirine, E. P. Kurniawati, S. Pengajar, F. Ekonomika, D. Bisnis, and U. Salatiga, "PENGENDALIAN KUALITAS MENGGUNAKAN METODE SIX SIGMA (Studi Kasus pada PT Diras Concept Sukoharjo)," AJIE-Asian J. Innov. Entrep., vol. 02, no. 03, pp. 2477–3824, 2017, [Online]. Available: http://www.dirasfurniture.com
12. W. Kurniawan, "Mengurangi Tingkat Kecacatan Pada Proses Produksi Pipa API 14 Inch di PT Bakrie Pipe Industries," J. Tek. Ind., no. Tingkat Kecacatan Pada Proses Produksi Pipa, pp. 1–8, 2016.

13. R. Fitriana and N. Anisa, “Perancangan Pebaikan Kualitas Produk Baut dan Sekrup Menggunakan Metode Six Sigma dan Data Mining di PT. A,” J. Tek. Ind., vol. 9, no. 1, pp. 46–53, 2019, doi: 10.25105/jti.v9i1.4786.
14. P. Moengin, R. Fitriana, and B. Ramadhan, “Perancangan Sistem Pendukung Keputusan untuk Pengendalian Kualitas pada Departemen Blow PT.D,” J. Tek. Ind., vol. 7, no. 3, pp. 188–207, 2017.
15. S. Harianto, E. Nursanti, and D. Indra Laksmana, “Aplikasi Metode Six Sigma Untuk Peningkatan Kualitas Dan Penjualan Kerajinan Cor Kuningan Tradisional Majapahit MojokertoYang Ramah Lingkungan,” J. Teknol. Dan Manaj. Ind., vol. 6, no. 1, pp. 21–26, 2020, doi: 10.36040/jtmi.v6i1.2626.
16. F. Ahmad, “Six Sigma Dmaic Sebagai Metode Pengendalian Kualitas Produk Kursi Pada Ukm,” Jisi Um, vol. 6, no. 1, p. 7, 2019, [Online]. Available: https://jurnal.umj.ac.id/index.php/jisi/article/view/4061
17. W. Kurniawan, “Sistem Manajemen Keamanan Pangan ISO 22000 Untuk Industri Yang Berhubungan Dengan Pangan,” J. Tek. Ind., vol. 1, no. 2, pp. 155–160, 2011, doi: 10.25105/jti.v1i2.7002. [18] M. Arifin and H. H. Supriyanto, “Aplikasi Metode Lean Six Sigma Untuk Usulan Improvisasi Lini Produksi Dengan Mempertimbangkan Faktor Lingkungan,” J. Tek. ITS, vol. 1, no. ISSN: 2301-9271, pp. A477–A481, 2012.
18. T. S. Dewayana, D. Sugiarto, and D. Hetharia, “Model Pemilihan Industri Komponen Otomotif Yang Ramah Lingkungan,” J. Tek. Ind., vol. 3, no. 3, pp. 208–216, 2013, doi: 10.25105/jti.v3i3.1564.
19. T. G. Amran, T. SD, and O. Prasyudi, “Model Evaluasi Kinerja Vendor,” J. Tek. Ind., vol. 4, no. 2, 2014, doi: 10.25105/jti.v4i2.1550.

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Improving the Packaging Quality of Surgical Suture Products at PT. XYZ with the Application of the Six Sigma Method and Failure Mode Effect Analysis (FMEA)

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Abstract. The medical industry today upholds strict quality standards for medical products, including surgical sutures. PT XYZ, a leading manufacturer in this sector, faces challenges in mitigating surgical suture product defects. This research focuses on the packaging of surgical suture products produced by PT XYZ, with a focus on the production period from January to March. During this time period, there was a significant level of packaging production defects. The aim of future research is to improve the quality of packaging for surgical suture products. Specifically, it aims to identify the causes of defects in PT The Six Sigma method, using DMAIC, will be used in this research. The Define stage combines tools such as the Supplier, Input, Process, Output, and Customer (SIPOC) diagram, along with Critical to Quality (CTQ) identification. The Measure stage involves calculations using the P control chart, C control chart, DPMO, and sigma level. During the Analysis phase, a thorough analysis of the causes of failure is carried out using tools such as Pareto diagrams, fishbone diagrams, and Failure Mode Effects Analysis (FMEA). Moving to the Improve stage, FMEA identifies high-risk defects, including torn cartons, inconsistent colors, and damp cartons. Therefore, the proposed defect repair involves analysis of 5W 1H cartons. The results of the analysis provide alternative solutions such as increasing the frequency of replacing cutting tools on mold cutting machines, using cleaning aids on molding machines, and improving environmental monitoring SOPs in factories. An additional suggestion is to include antiseptic wet wipes in each carton of surgical suture products. After making improvements in the Improve stage, the final Control stage is carried out to assess the impact of the proposed changes on the company. The results show a positive impact, with an increase in the sigma value to 3.670.

1 Introduction

PT. XYZ is a manufacturing company that produces Surgical Sutures (surgical needles) in large quantities every day. Companies face high pressure to improve product quality due

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to increasing customer demands and industry competition. PT. XYZ implements a make-to-order production system to avoid wasting costs.

The company's main product is surgical suture, which is used in surgical procedures to suture cut or torn body tissue. There are several types of Surgical Suture products, with this research focusing on the Elvalene product. The company has a defect rate of 6%, including attribute and variable defects. Variable defects appear during the production process, while attribute defects are related to problems in the packaging process.

Even though there is process control, PT. XYZ has not achieved the desired quality target. Therefore, this research focuses on Elvalene product packaging with the aim of reducing the percentage of defects, improving product quality, and increasing customer trust.

One approach used is the Six Sigma method, which aims to minimize product variations and increase process capabilities [1]. The Six Sigma concept is used in the DMAIC (Define, Measure, Analyze, Improve, Control) cycle, with tools such as the Pareto Chart and Failure Mode and Effect Analysis (FMEA). The implementation of Six Sigma in the packaging process is expected to reduce the number of defective products produced, increase profits, and help companies achieve targeted quality standards.

The type of product that has the highest percentage of defects produced by the company is elvalene at 5.21%. The focus of this research focuses on the packaging of elvalene type products with the problems faced by companies that have not achieved the quality target for elvalene type surgical suture products. This type of elvalene product which is produced in large quantities has quite a large impact on defect results. Elvalene type products have 2 types of defects, namely defects in the needle attaching inspection process and defects in the packaging inspection process.

The company generalizes that the defect tolerance limit is 3%. From **Fig.1** it can be seen that the percentage of packaging defects is 4%, which means it is greater than needle attaching defects whose percentage is 2%. Therefore, improvements need to be made to the Elvalene product packaging process.

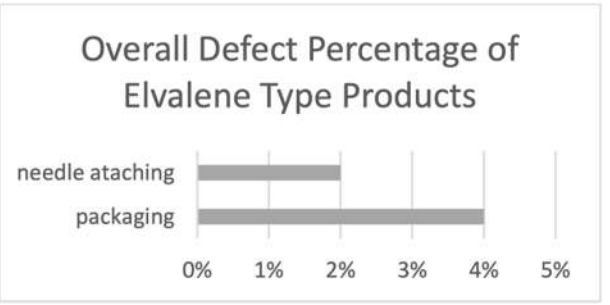


Fig. 1. Overall defect percentage of elvalene type products

2 Literature review

2.1 Define

In the Define stage, the first step is to identify the problem being faced to gain a deeper understanding of the problem being faced. In this process, tools such as the SIPOC diagram (Supplier, Input, Process, Output, Customer) are used to outline the main components in the process. Apart from that, this stage also involves the introduction of CTQ (Critical To Quality), namely factors that are key in maintaining product or service quality [2]. Identifying the problem and these critical elements is an important first step in ensuring that improvement efforts are aligned with organizational needs and customer satisfaction.

2.2 Measure

The next stage in DMAIC is the Measure stage, which involves analyzing the data that has been collected. In the context of this research, the use of control charts will be one of the main components of the Measure stage. Control charts are used to assess whether the process results are in a normal state or not, by referring to the values of UCL (Upper Control Limit), CL (Center Line), and LCL (Lower Control Limit) as control limits [3]. The data that has been analyzed will be represented in graphical form. At this Measure stage, calculations will also be carried out to determine the DPMO (Defects Per Million Opportunities) value and sigma level.

2.3 Analyze

The next step, namely the analyze stage, involves an in-depth analysis related to the root causes of failure in the production process [4]. In this analysis stage, various analysis tools are used, including Pareto diagrams, fishbone diagrams, and also analysis using the Failure Mode Effect Analysis (FMEA) method.

2.4 Improve

The next step is Improve, where changes will be implemented to improve process performance, and solutions will be developed to overcome the problems to be fixed [5].

2.5 Control

After implementing the recommendations for improvements that have been proposed, the next stage is the control stage, which aims to evaluate whether the solution implemented has a positive impact on the company.

3 Method

Fig. 2 show the research methodology flowchart.

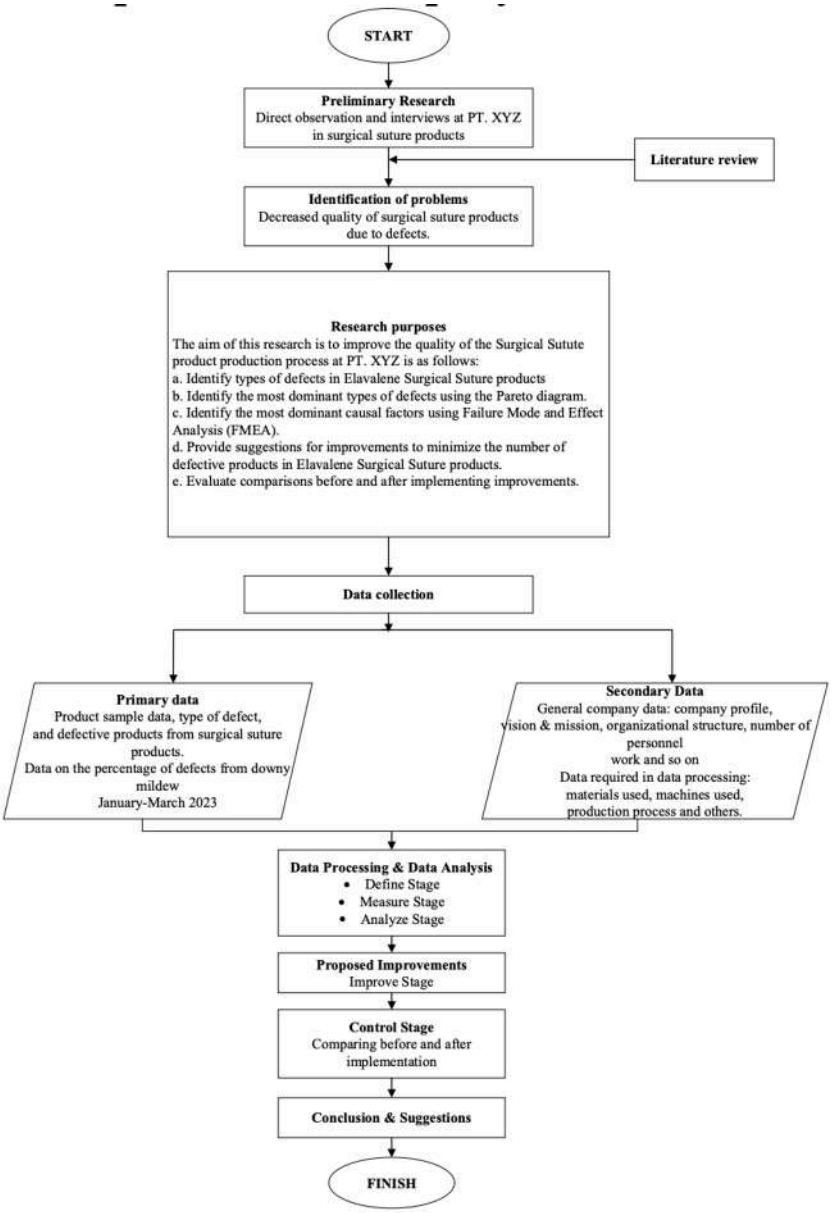


Fig. 2. Research methodology flowchart

4 Result

4.1 Define

The first step in the DMAIC method is the define stage which aims to identify opportunities for improvement in the quality of surgical suture products and their production processes. This stage includes the introduction of various aspects related to the product. Next, production and defect data are collected to identify key characteristics

in product quality (CTQ). The creation of SIPOC diagrams is used to describe in detail the production process and raw material flow, from raw material collection to the final product to the customer or warehouse.

PT XYZ has set quality standards for each product produced, with the aim of ensuring that these products can meet customer needs and preferences. The Critical To Quality (CTQ) identification process is used to recognize important aspects in the quality of surgical suture products that meet customer expectations [6]. CTQ identification is carried out by identifying the quality characteristics of the product that fall into the good category, as well as the quality characteristics that fall into the bad or defective category.

This quality standard is focused on the packaging process of elvalene surgical suture products set by the company and customer requests, which are as follow **Table 1**.

Table 1. The sipoc diagram

Supplier	Input	Process	Output	Customer
Korean & Chinese Vendors	Raw materials for spools of thread ± 500 m & Surgical needles	Delivery and receipt of raw materials to the warehouse	Incoming Raw Material Stock	Raw Material Warehouse
Raw Material Warehouse	Incoming Raw Material Stock	Raw material inspection	Spools of Yarn	Yarn Winding Place
Yarn Winding Place	Spools of Yarn	Unwinding	Results of spools of thread	Unwinding Machine
Winding Machine	Results of spools of thread	Cutting	Thread Piece 90 cm	Operator
Operator	Thread Piece 90 cm	Needle Attaching	Thread that has been connected to a needle	Operator
Operator	Thread that has been connected to a needle	Winding	thread & needle unit that has been inserted into in a plastic tray	Winding Machine
Winding Machine	thread & needle unit that has been inserted into in a plastic tray	Primary Packaging	Products that have been placed in aluminum foil	Operator
Operator	Products that have been placed in aluminum foil	Sterilization	Products that have been sterilized	EtO Machine
EtO Machine	Products that have been sterilized	Sealing & Blanking	Products that have aluminum foil installed	Sealing & Blanking Machine
Sealing & Blanking Machine	Products that have aluminum foil installed	Secondary Packaging	Products that have been put in cardboard	Packing place
Material Warehouse packaging place	Products that have been put in cardboard	Surgical suture product packaging process	Stack of surgical suture products	Finished Goods Warehouse

4.1.1 Torn cardboard

Surgical suture packaging cardboard should not be torn. Torn product cardboard defects are damage to the product packaging that results in holes or tears in the cardboard. Some common physical features of this defect are tears in cardboard, usually seen in the form of tears, namely parts of the cardboard that are separated or torn apart. Tears can be small or large, depending on the cause and extent of the damage. Torn defects can be in the form of holes or holes in the cardboard. These holes can be small or large, and they can result in damage to the product inside if not properly addressed.

4.1.2 Print error

The molded parts of the surgical suture packaging cardboard should not experience printing errors. Misprinted product packaging cardboard defects are a type of defect that occurs when the printing process on the cardboard used to package the product produces an error or the print does not match the desired design. These defects can involve a variety of printing issues, such as Incorrect Insertion of Text on a print can result in incorrect text, or even text that is completely different than what should be on the packaging. The wrong print position is the print that is not in the correct position on the cardboard, so that the desired image or text does not match the desired position.

4.1.3 Color does not match

There should be no elavelene surgical suture packaging cardboard that has color nonuniformity. A defect in product packaging cardboard that is not uniform in color is a type of defect that occurs when the cardboard used to package the product has striking differences in color or appearance between different parts of the cardboard. This color difference can occur on parts that should have a uniform color, such as the outer surface of the cardboard or the printing on the cardboard.

4.1.4 Damp cardboard

In surgical suture packaging cardboard, there should be no moisture absorption. Defects in cardboard packaging a damp product is a condition where the cardboard used to package the product absorbs or maintains high levels of moisture, in the form of the cardboard becoming soft or soft.

4.2 Measure

At this stage, measurements are taken to analyze existing problems using various tools, such as P and C attribute control maps, as well as evaluation of DPMO values and sigma levels.

4.2.1 P control map

The p control map is used to monitor the process based on the proportion of defects that are not in accordance with the standard specifications set by the company [8]. **Table 2** contains the calculation of the p control map used to assess the proportion of defects based on observation data during February-March of 2023.

Table 2. Calculation of P control map

Day	Date	Number of Production Samples (Pcs)	Number of Defective Products (Pcs)	Proportion of Defective Products	CL	UCL	LCL
1	13-Feb	35	3	0,08571	0,1143	0,2756	-0,437
2	14-Feb	35	2	0,05714	0,1143	0,2756	-0,561
3	15-Feb	35	3	0,08571	0,1143	0,2756	-0,437
4	16-Feb	35	4	0,11429	0,1143	0,2756	-0,363
5	17-Feb	35	6	0,17143	0,1143	0,2756	-0,275
6	20-Feb	35	3	0,08571	0,1143	0,2756	-0,437
7	21-Feb	35	3	0,08571	0,1143	0,2756	-0,437
8	22-Feb	35	6	0,17143	0,1143	0,2756	-0,275
9	23-Feb	35	2	0,05714	0,1143	0,2756	-0,561
10	24-Feb	35	5	0,14286	0,1143	0,2756	-0,313
11	27-Feb	35	5	0,14286	0,1143	0,2756	-0,313
12	28-Feb	35	5	0,14286	0,1143	0,2756	-0,313
13	01-Mar	35	6	0,17143	0,1143	0,2756	-0,275
14	02-Mar	35	5	0,14286	0,1143	0,2756	-0,313
15	03-Mar	35	4	0,11429	0,1143	0,2756	-0,363
16	06-Mar	35	3	0,08571	0,1143	0,2756	-0,437
17	07-Mar	35	2	0,05714	0,1143	0,2756	-0,561
18	08-Mar	35	5	0,14286	0,1143	0,2756	-0,313
19	09-Mar	35	3	0,08571	0,1143	0,2756	-0,437
20	10-Mar	35	5	0,14286	0,1143	0,2756	-0,313

$$CL = \bar{p} = \frac{\sum p}{inspection\ total} = \frac{80}{700} = 0.2286 \quad (1)$$

$$UCL = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{35}} = 0.2286 + 3\sqrt{\frac{0.2286(1-0.2286)}{35}} = 0.4415 \quad (2)$$

$$LCL = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{35}} = 0.2286 - 3\sqrt{\frac{0.2286(1-0.2286)}{35}} = 0.0156 \quad (3)$$

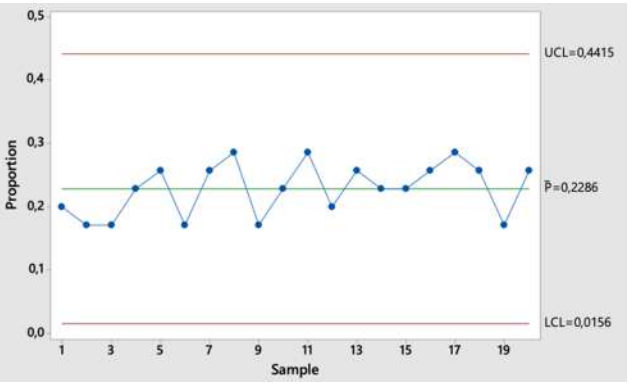


Fig. 3. Plot of P control map data

From the results of calculations and data plots (**Fig. 3**), it can be concluded that the data can be considered under control or within the control range, so the next step is to calculate the DPMO value and sigma level.

4.2.2 Control map C

The C control map is used to monitor the number of defects that appear in the product produced, not the defective product itself [8]. **Table 3** is the result of the calculation of the C control map used to record the number of these defects.

Table 3. Calculation of C control map

Day	Date	Number of Production Samples (Pcs)	Number of Defective Products (Pcs)	Proportion of Defective Products	CL	UCL
1	13-Feb	35	7	8	16,485	0
2	14-Feb	35	6	8	16,485	0
3	15-Feb	35	6	8	16,485	0
4	16-Feb	35	8	8	16,485	0
5	17-Feb	35	9	8	16,485	0
6	20-Feb	35	6	8	16,485	0
7	21-Feb	35	9	8	16,485	0
8	22-Feb	35	10	8	16,485	0
9	23-Feb	35	6	8	16,485	0
10	24-Feb	35	8	8	16,485	0
11	27-Feb	35	10	8	16,485	0
12	28-Feb	35	7	8	16,485	0
13	01-Mar	35	9	8	16,485	0
14	02-Mar	35	8	8	16,485	0
15	03-Mar	35	8	8	16,485	0
16	06-Mar	35	9	8	16,485	0
17	07-Mar	35	10	8	16,485	0
18	08-Mar	35	9	8	16,485	0
19	09-Mar	35	6	8	16,485	0
20	10-Mar	35	9	8	16,485	0
TOTAL		700	160			

$$CL = \bar{c} = \frac{\sum c}{\sum k} = \frac{160}{20} = 8 \quad (4)$$

$$UCL = \bar{c} + 3\sqrt{\bar{c}} = 8 + 3\sqrt{8} = 0.16485 \quad (5)$$

$$LCL = \bar{c} - 3\sqrt{\bar{c}} = 8 - 3\sqrt{8} = 0.485 \approx 0 \quad (6)$$

The results of calculations and data plots (**Fig. 4**) show that the data can be said to be in control or already within the control limits so that it can be continued to calculate the DPMO value and sigma level.

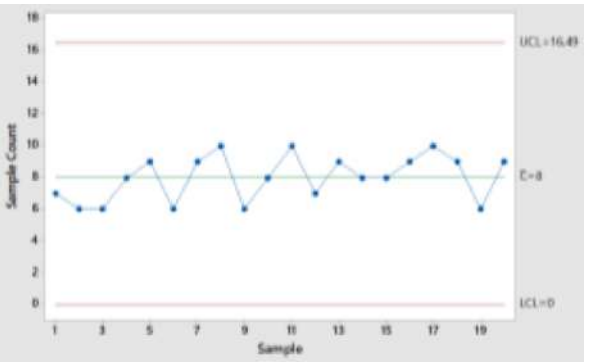


Fig. 4. Plot of C control map data

4.2.3 Calculation of DPMO and sigma level

Based on the calculation of the control map, the calculation of DPMO & Sigma Level is then carried out.

$$DPU = \frac{defect}{unit} = \frac{160}{700} = 0.2286 \quad (7)$$

$$DPO = \frac{defect}{unit\ x\ opportunity} = \frac{120}{700\ x\ 4} = 0.042857 \quad (8)$$

$$DPMO = DPO\ x\ 1{,}000{,}000 = 0.042857\ x\ 1{,}000{,}000 = 42.857 \quad (9)$$

$$Sigma\ level = normsinv\left(1 - \frac{DPMO}{1{,}000{,}000}\right) + 1.5 = normsinv\left(1 - \frac{42.857}{1{,}000{,}000}\right) + 1.5 = 3.218 \quad (10)$$

4.3 Analyze

4.3.1 Pareto diagram

Pareto diagrams are used to determine the most dominant defects of a product [9]. This stage analyzes and identifies the causes of defects from each production process. Based on the results of observations, there are types of defects in surgical suture packaging products. To identify the most dominant defects, a pareto diagram with the 80:20 principle was used. This principle indicates that 80% of defects are caused by 20% of the causes. Based on the **Fig. 5**, the defects with the highest frequency are torn cardboard, inconsistent color on the packaging and damp cardboard. They reach 56.3% 21.9% and 15.6% respectively. Therefore, it can be concluded that the priority for analyzing the causal factors of defects is on these three types of defects.

After getting the most dominant types of defects, namely torn cardboard, inappropriate color and moisture, an analysis of the causes of the dominant defects is carried out using the Ishikawa diagram.

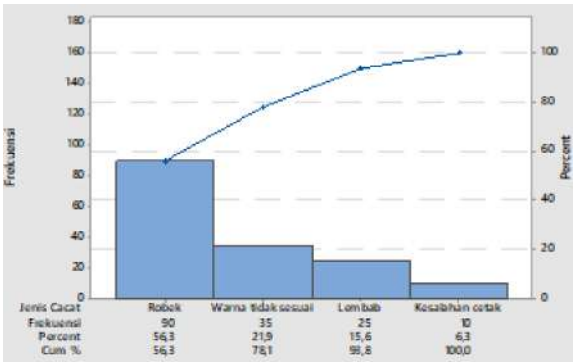


Fig. 5. Pareto diagram of defect types

4.3.2 Ishikawa diagram

The Ishikawa diagram, also known as a fishbone diagram, is a tool that has similarities to the shape of a fishbone [10]. This diagram is used to illustrate the relationship between the causes and effects of a problem at hand. In the Ishikawa diagram, there are five factors known as the cause of an effect, namely man, machine, method, material, and environment. Below, there is an example of an Ishikawa diagram that illustrates the causal factors that play the most role in the types of defects that dominate, namely torn cardboard, inconsistent colors on packaging and cardboard units as shown in **Fig. 6** to **Fig. 8**.

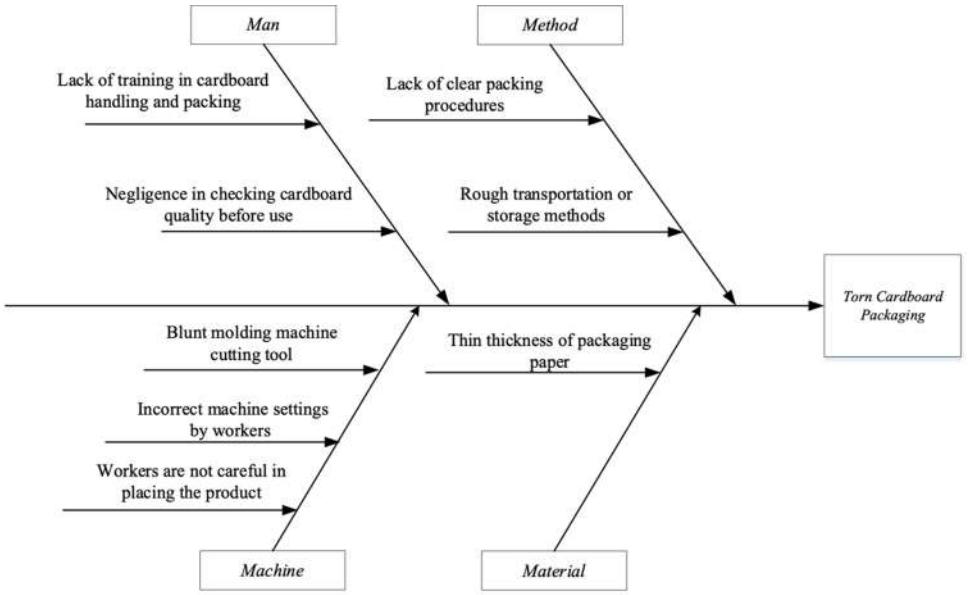


Fig. 6. Fishbone diagram of types of cardboard packaging defects

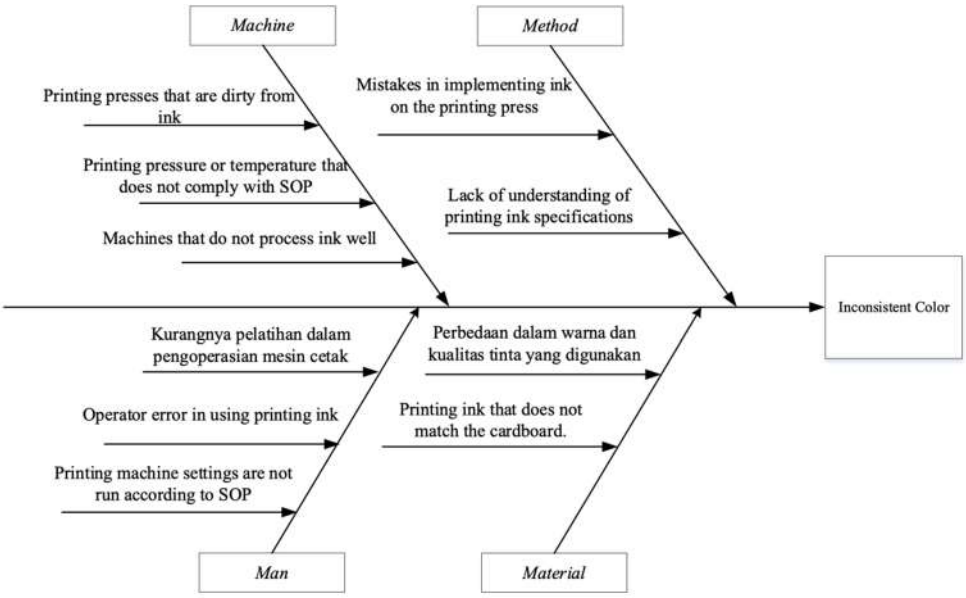


Fig. 7. Fishbone diagram of defect type inconsistent color

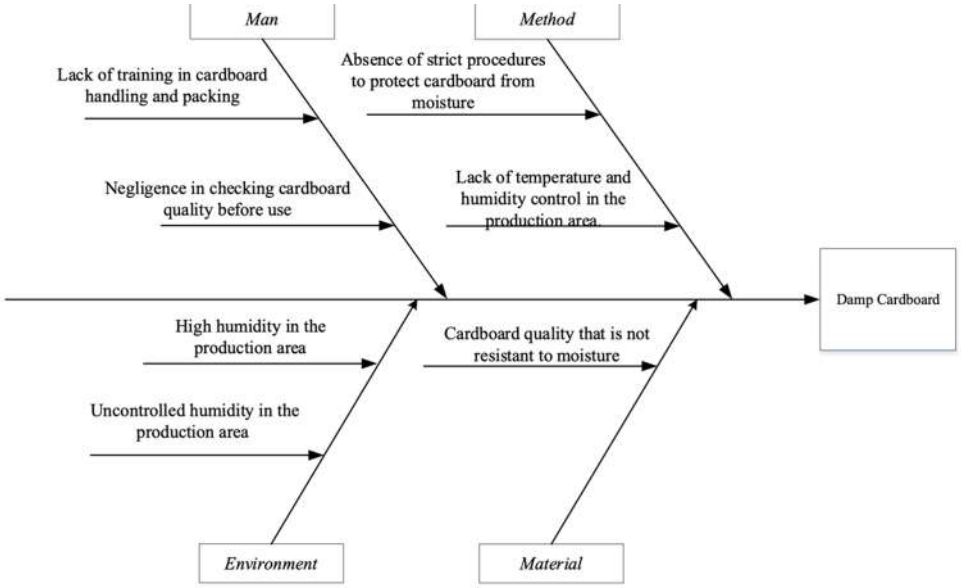


Fig. 8. Fishbone diagram of types of damp defects

4.3.3 Failure mode effect analysis (FMEA)

Failure Mode Effect Analysis (FMEA) is a method used to improve safety in the process by identifying and preventing potential failures or errors that can occur during the production process [11]. There are three parameters used in FMEA calculations, namely severity, occurrence, and detectability. From these three parameters, the RPN (Risk Priority Number) value is obtained, where the highest RPN value is a priority in making

improvements. **Table 4** contains the results of FMEA calculations with RPN values obtained through interviews.

Table 4. Calculation of failure mode effect analysis value

Process	Type of failure	Effects Arising from Failure	Causes of Process Failure	Controls that have been carried out	D	RPN
Packaging process	Torn Cardboard	Loss of Product Value and Lack of Protection	Operators are not careful in assembling the product	Review the methods used to move raw materials or products	5	245
			Rough methods of transportation or storage		5	210
			Blunt printing machine cutting tool	Replace cutting tools once every 2 weeks	6	336
	Inconsistent Colors	Declining Brand Image and Lack of Uniformity in the Market	Ink quality varies within each batch	Check ink raw materials according to SOP provisions	5	245
			Lack of clear procedures to achieve color consistency		5	175
			The machine is dirty due to ink sticking to the printing machine	Cleaning once a week	5	280
	Moist	Decreased Durability of Cardboard	Production or storage devices that are not protected from moisture	Check room temperature suitability	6	210
			Lack of temperature and humidity control in production areas		6	252
			The absence of strict procedures to protect cardboard from moisture		5	245
	Print Error	Product Identification and Information Errors	Differences in color and quality of ink used	Regular inspection and supervision of operator performance (every 2 weeks)	5	210
			Printing ink that does not match the cardboard		5	245
			Lack of training in printing machine operation		5	175

After identifying potential failures using FMEA, there are 12 causes of failure that occur with RPN values that have been calculated with the values of S, O, and D. Potential failures that are prioritized in making improvements are those with the highest RPN values. From the FMEA results, the failure of torn cardboard with the cause of the cutting tool on the blunt mold cutting machine has the highest RPN value of 336. As for the type of failure, the color is inconsistent with the cause because the printing machine is dirty due to the ink attached to the printing machine and has an RPN value of 280. And for the failure of damp cardboard with the cause of the lack of temperature and humidity control in the production area which has an RPN value of 252. This cause will be the focus of the proposed improvements.

4.3.4 5W 1H

The 5W 1H method is an approach or framework used to detail and better understand an event or problem [11]. This 5W+1H method is very useful because it helps identify and detail important information needed for a better understanding of a particular situation. This method was carried out after knowing the two largest RPNs from the Failure Mode and Effect Analysis (FMEA) method, namely the type of torn cardboard defect with the cause of the operator being less careful in placing the product and the type of print error

defect with the cause of the printing machine settings not being carried out according to company directions.

4.4 Improve

The Improve stage is the step after the Analyze stage in improving the quality of surgical suture products. The goal is to propose improvements that can reduce product defect rates and increase product sigma levels [12]. Proposed improvements are made based on the identification of potential causes of failure using tools such as Pareto Diagrams, p and c Control Maps, Fishbone Diagrams, FMEA, and 5W 1H (**Table 5**), which have been used previously in the Define, Measure, and Analyze stages. These proposed improvements were generated through a brainstorming session with Ms. Keithy, head of QC staff, with the hope that the planned improvements would improve product quality and reduce defects in surgical suture products. The list of proposed improvements can be found in Table 6.

Table 5. 5W 1H Analysis

Factor	Blunt printing machine cutting tool	Dirty printing machine	Lack of temperature and humidity control in production areas
What	Printing machine cutting tools are blunt due to cutting with a capacity of 300 pcs	The operator did not clean the printing machine Routinely	Temperature control in production areas is not monitored properly and there is a lack of regular checks
Why	So that the printing machine's cutting tools are not blunt, thereby reducing defects in torn cardboard	So that operators clean the printing machine so that they can reduce inconsistent color defects	So that temperature and humidity are controlled thereby reducing defects in torn cardboard
Where	At the production site, packaging section	At the production site, print packaging section	In the factory temperature, humidity and pressure monitoring room
When	Before starting the shift	Before starting the shift	Before starting the shift
Who	Production operator	Production operator	Staff Engineering
How	Reducing the cutting capacity of cardboard molds to 150 pcs and checking forms as a control tool	Remind the operator to carry out cleaning with the tool and also with the form as a control tool	Improved the factory environmental monitoring sop and added a factory environmental monitoring data analysis results worksheet

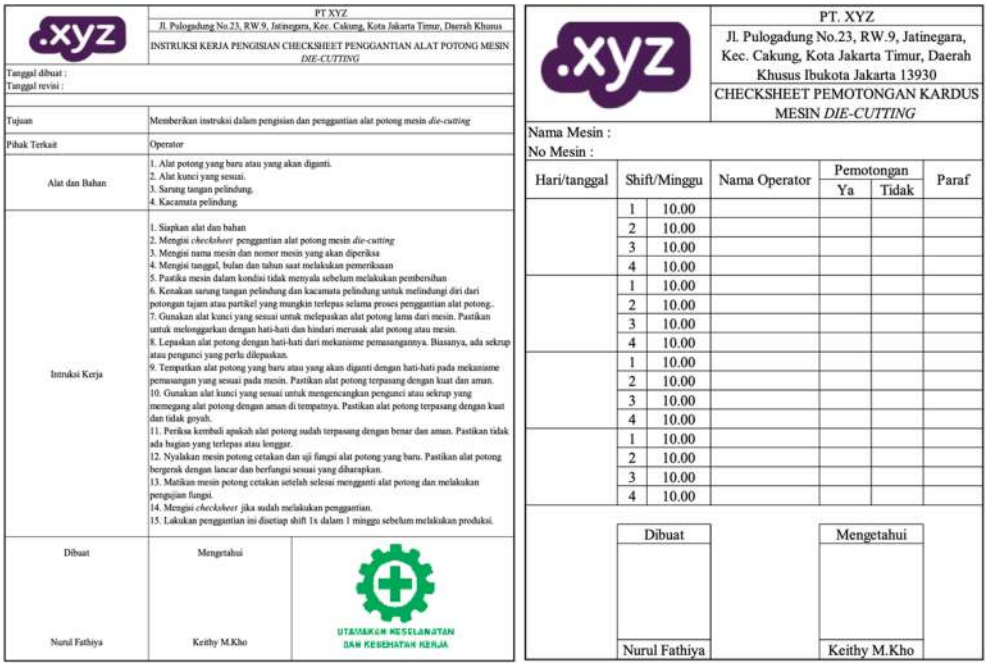
Table 6. Proposed improvements

No	Failure	Causes of failure	Proposed improvements
1	Shredded Cardboard	Blunt printing machine cutting tools	Reduced the cutting capacity of cardboard molds from 300 Pcs to 150 Pcs
			Reducing the cutting capacity of cardboard molds to 150 Pcs using the form as a control tool
2	Inconsistent colors	Dirty printing machine	Cleaning aids and cleaning fluids
			Perform daily machine cleaning using the form as a control tool
3	Humid	Lack of temperature and humidity control in the production area	Improve SOPs for Factory Environmental Monitoring
			Adding a Worksheet on the Results of Factory Environment Management Data Analysis as a control tool

4.4.1 Proposed increase in frequency of cutting tool replacement

The company uses a Die-cutting machine to cut the printed cardboard patterns. This machine is used to cut various types of materials into the desired shape with the help of a special mold called a "die". Die-cutting machine operators are responsible for setting up the machine, replacing the die if needed, and monitoring the quality of the products produced.

After analysis through the 5W 1H table, it was found that the cause of the torn cardboard defect was due to the blunt cutting tool of the die-cutting machine. This is due to the infrequent replacement frequency of the cutting tools, which resulted in torn surgical suture cardboard products. Therefore, the proposed improvement is to increase the frequency of cutting tool replacement from 2 weeks 1x to 1 week 1x, with necessary supervision and check sheet revision. This has been discussed with the person in charge of production and implemented in the revised work instruction (**Fig. 9**) with cutting tool changeover performed every time before starting the shift. The aim is to reduce the incidence of defects in torn cardboard products in the future.



PT XYZ
Jl. Pulogadung No.23, RW.9, Jatinegara, Kec. Cakung, Kota Jakarta Timur, Daerah Khusus

INSTRUKSI KERJA PENGISIAN CHECKSHEET PENGGANTIAN ALAT POTONG MESIN *DIE-CUTTING*

Tanggal dibuat :
Tanggal revisi :

Tujuan	Memberikan instruksi dalam pengisian dan penggantian alat potong mesin *die-cutting*
Pihak Terkait	Operator
Alat dan Bahan	1. Alat potong yang baru atau yang akan diganti. 2. Alat kunci yang sesuai. 3. Sarung tangan pelindung. 4. Kacamata pelindung.
Intruksi Kerja	1. Siapkan alat dan bahan 2. Mengisi *checksheet* penggantian alat potong mesin *die-cutting* 3. Mengisi nama mesin dan nomor mesin yang akan diperiksa 4. Mengisi tanggal, bulan dan tahun saat melakukan pemeriksaan 5. Pastika mesin dalam kondisi tidak menyala sebelum melakukan pembersihan 6. Kenakan sarung tangan pelindung dan kacamata pelindung untuk melindungi diri dari potongan tajam atau partikel yang mungkin terlepas selama proses penggantian alat potong. 7. Gunakan alat kunci yang sesuai untuk melepaskan alat potong lama dari mesin. Pastikan untuk melonggarkan dengan hati-hati dan hindari merusak alat potong atau mesin. 8. Lepaskan alat potong dengan hati-hati dari mekanisme pemasangannya. Biasanya, ada sekrup atau pengunci yang perlu dilepaskan. 9. Tempatkan alat potong yang baru atau yang akan diganti dengan hati-hati pada mekanisme pemasangan yang sesuai pada mesin. Pastikan alat potong terpasang dengan kuat dan aman. 10. Gunakan alat kunci yang sesuai untuk mengencangkan pengunci atau sekrup yang memegang alat potong dengan aman di tempatnya. Pastikan alat potong terpasang dengan kuat dan tidak goyah. 11. Periksa kembali apakah alat potong sudah terpasang dengan benar dan aman. Pastikan tidak ada bagian yang terlepas atau longgar. 12. Nyalakan mesin potong cetakan dan uji fungsi alat potong yang baru. Pastikan alat potong bergerak dengan lancar dan berfungsi sesuai yang diharapkan. 13. Matikan mesin potong cetakan setelah selesai mengganti alat potong dan melakukan pengujian fungsi. 14. Mengisi *checksheet* jika sudah melakukan penggantian. 15. Lakukan penggantian ini disetiap shift 1x dalam 1 minggu sebelum melakukan produksi.

Dibuat	Mengetahui	
Nurul Fathiya	Keithy M.Kho	UTAMAKAN KESELAMATAN DAN KESEHATAN KERJA

PT. XYZ
Jl. Pulogadung No.23, RW.9, Jatinegara, Kec. Cakung, Kota Jakarta Timur, Daerah Khusus Ibukota Jakarta 13930
CHECKSHEET PEMOTONGAN KARDUS MESIN *DIE-CUTTING*

Nama Mesin :
No Mesin :

Hari/tanggal	Shift/Minggu		Nama Operator	Pemotongan		Paraf
				Ya	Tidak	
	1	10.00				
	2	10.00				
	3	10.00				
	4	10.00				
	1	10.00				
	2	10.00				
	3	10.00				
	4	10.00				
	1	10.00				
	2	10.00				
	3	10.00				
	4	10.00				
	1	10.00				
	2	10.00				
	3	10.00				
	4	10.00				

Dibuat	Mengetahui
Nurul Fathiya	Keithy M.Kho

Fig. 9. Work instruction for check sheet filling and die-cutting tool replacement

4.4.2 Proposed use of printing press cleaning aids

Printing presses are industry-specific equipment used to print various types of packaging. The company uses a Ranger Type XP600 indoor digital printing machine to print surgical suture product packaging. It is important to choose a printing machine that suits the production needs to maintain quality and efficiency. Inconsistent color defects in cardboard are caused by ink impurities on the printing machine. Therefore, the use of a

molding machine cleaning tool is proposed as a solution. This proposal came about because the company did not have effective equipment to clean the molding machine. Trials were conducted to select suitable cleaning equipment and fluids based on the criteria of price, cleaning time, and finish.

After trials, the decision was made to use chamois and solvent cleaner as cleaning tools that were more economical, time-efficient, and effective in keeping the print screen clean and protected. This decision was based on the affordable price, faster cleaning process, and the chamois' ability to absorb ink well compared to a rag. The chamois used has dimensions of 32 cm × 20 cm, weighs about 30 grams per sheet, and is made from the main raw material of microfiber. Solvent cleaner was chosen as the cleaning fluid because it is safe to remove ink without damaging the printing press. Fig. 10 illustrate the chamois and solvent cleaner.

Fig. 10. Chamois and solvent cleaner

Based on the results of the FMEA analysis, the cardboard color defect is not suitable because the printing machine is dirty. The cleaning of the molding machine that the company has been doing is done once a day with no routine after finishing production. But from the observation, there is dirt and dust on the machine and also the results of printing are not according to the desired standard. So, there is a need for routine cleaning. The proposal for routine cleaning was discussed with the person in charge of production to be 3 times a day which is done at the end of each shift or before the break begins. This routine cleaning is then controlled by making existing check sheets and making work instructions which can be seen in Fig. 11.

4.4.3 Proposed improvements to the factory environmental monitoring SOPs

The Factory Environmental Monitoring Standard Operating Procedure (SOP) is a document that details steps and guidelines for factory staff in monitoring and controlling environmental conditions. This SOP aims to ensure compliance with environmental regulations, maintain sustainability, and prevent negative impacts on the surrounding environment. One aspect of improvement in the SOP is the identification and control of potential moisture sources in the factory, such as leaking pipes or leaking roofs, to prevent product damage. In addition, companies use Operational Management Systems (OOS) and Energy Management Systems (EMS) to efficiently regulate temperature and maintain appropriate temperature conditions in their facilities. An Operational Management System (OOS) is a system designed to monitor, control and optimize various operations

within a facility, including temperature regulation. OOS aims to improve operational efficiency, reduce costs, and maintain the comfort and safety of facility users. In terms of temperature regulation, OOS can manage HVAC systems to maintain a comfortable temperature and avoid wasting energy. Meanwhile, Energy Management Systems (EMS) focus more on optimizing energy use in facilities, including temperature regulation. EMS involves monitoring and controlling devices such as heaters, air conditioners, pumps, and others to improve energy efficiency with the aim of reducing energy consumption and costs, but still maintaining the temperature as needed. After analysis through the 5W 1H table, it was identified that the cause of the damp cardboard defect was the lack of temperature and humidity control in the production area due to the lack of organization in managing temperature by the engineering staff. Humidity is a risk factor for damage to cardboard packaging. Updating the SOP is the solution to identify more preventive measures effective in reducing the risk of cardboard becoming damp and deformed during production and storage.

.xyz	PT XYZ	
	Jl. Pulogadung No.23, RW.9, Jatinegara, Kec. Cakung, Kota Jakarta Timur, Daerah Khusus Ibukota Jakarta 13930	
	INSTRUKSI KERJA PENGISIAN CHECKSHEET PEMBERSIHAN MESIN CETAKAN	
Tanggal dibuat : Tanggal revisi :		
Tujuan	Memberikan instruksi dalam pengisian dan pembersihan mesin cetakan kardus packaging	
Pihak Terkait	Operator	
Alat dan Bahan	1. Sarung Tangan Karet 2. Kanebo 3. Cairan solvent clenaer	
Intruksi Kerja	1. Siapkan alat dan bahan 2. Mengisi *checksheet* pembersihan mesin cetakan 3. Mengisi nama mesin dan nomor mesin yang akan diperiksa 4. Mengisi tanggal, bulan dan tahun saat melakukan pemeriksaan 5. Pastika mesin dalam kondisi tidak menyala sebelum melakukan pembersihan 6. Angkat penutup mesin cetakan sehingga ada jarak antara penutup dan mesin cetakan 7. Bersihkan mesin cetakan dari sisa-sisa tinta hasil *printing* dan kotoran yang menempel pada mesin dengan kanebo dan larutan *solvent cleaner* 8. Periksa kembali apakah mesin cetakan sudah bersih dan tunggu 15 detik sampai larutan mengering 9. Mengisi *checksheet* jika sudah melakukan pembersihan 10. Lakukan pembersihan ini disetiap shift setelah selesai melakukan produksi.	
Dibuat Nurul Fathiya	Mengetahui Keithy M.Kho	UTAMAKAN KESELAMATAN DAN KESEHATAN KERJA

.xyz			PT. XYZ			
			Jl. Pulogadung No.23, RW.9, Jatinegara, Kec. Cakung, Kota Jakarta Timur, Daerah Khusus Ibukota Jakarta 13930			
			CHECKSHEET PEMBERSIHAN MESIN CETAKAN			
Nama Mesin : No Mesin :						
Hari/tanggal	Shift/Jam		Nama Operator	Pembersihan		Paraf
				Ya	Tidak	
	1	10.00				
	2	12.00				
	3	16.00				
	1	10.00				
	2	12.00				
	3	16.00				
	1	10.00				
	2	12.00				
	3	16.00				
	1	10.00				
	2	12.00				
	3	16.00				
	1	10.00				
	2	12.00				
	3	16.00				
	1	10.00				
	2	12.00				
	3	16.00				
	1	10.00				
	2	12.00				
	3	16.00				
	Dibuat Nurul Fathiya			Mengetahui Keithy M.Kho		

Fig. 11. Work instruction for check sheet filling and cleaning molding machine

Engineering staff who are less familiar with EMS and OOS need more detailed explanations to understand their potential and benefits. Improving the SOPs with more detailed explanations will improve their understanding of how these systems work and the benefits that can be gained. With a better understanding of the use of EMS and OOS, engineering staff can more effectively optimize energy use and facility operations, which can reduce the risk of damp cardboard due to inappropriate temperatures. Proposed improvements to the factory's environmental monitoring SOPs were discussed with the

person in charge of production and overseen by the creation of OOS and EMS data sheets and EMS & OOS data analysis results worksheets documented in **Fig. 12** and **Fig. 13**.

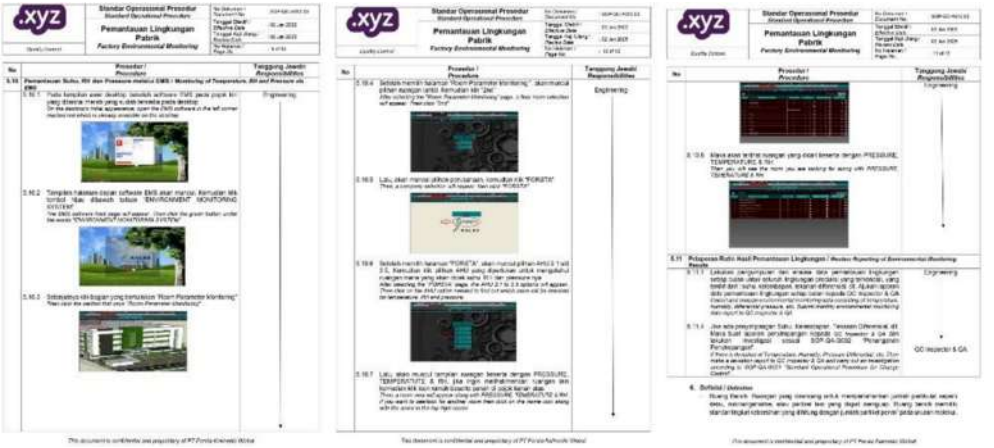


Fig. 12. Improvement of factory environmental monitoring SOP

Fig. 13. EMS OOS data analysis result worksheet

4.4.4 Proposed additional antiseptic wet wipes on each cardboard package

The addition of antiseptic wet wipes in each cardboard package of surgical suture products because antiseptic wet wipes play an important role in maintaining hygiene (**Fig. 14**). In the context of surgical procedures, maintaining the area around the wound or incision prior to suture application is essential to prevent infection. Antiseptic wet wipes can effectively clean and help eliminate potentially harmful microorganisms. Furthermore, the addition of antiseptic wet wipes also strengthens the sterilization aspect of the product. As surgical sutures need to remain sterile before being used on patients, antiseptic wet wipes included in the packaging can help ensure that the product remains sterile during storage and transportation. This is a key step in meeting the safety and quality standards required in the medical field.

Fig. 14. Antiseptic/alcohol cotton

The healthcare professional caring for the patient will have easy access to the antiseptic cleaning tools required to carry out the procedure correctly. This can save time and ensure that every necessary step can be performed well before the use of surgical sutures. Furthermore, the addition of antiseptic wet wipes also reduces the risk of infection. By cleaning the wound or incision area before using surgical sutures, the risk of contamination can be minimized. This is crucial in the quest to achieve optimal surgical outcomes and maintain patient well-being. The addition of antiseptic wet wipes to cardboard packaging is a step that has significant benefits in maintaining hygiene, sterilization, ease of use, reduction of infection risk, and patient safety in the context of surgical care.

4.5 Control

The Control phase is the last step applied in the six-sigma methodology. In this phase, the implementation of improvement suggestions has been carried out in accordance with the suggestions that have been designed at the Improvement stage. Of the 6 improvement suggestions that have been formulated, there is one suggestion that cannot be implemented in this study (**Table 7**). This situation occurs due to time constraints in the implementation of improvement suggestions.

Table 7. Implementation of proposed improvements

No	Failure	Causes of failure	Proposed improvements	Implementation
1	Shredded Cardboard	Blunt printing machine cutting tools	Reducing the frequency of long replacement of printing machine cutting tools from 1x in 2 weeks to 1x in 1 week	Yes
			Replace the cutting tools of the printing machine every 1 week 1x by using the form as a control tool	Yes
2	Inconsistent colors	Dirty printing machine	Cleaning aids and cleaning fluids	No
			Perform daily machine cleaning using the form as a control tool	Yes
3	Humid	Lack of temperature and humidity control in the production area	Improve SOPs for Factory Environmental Monitoring	Yes
			Adding a Worksheet on the Results of Factory Environment Management Data Analysis as a control tool	Yes

4.5.1 Calculation of control map after implementation

The calculation of the p control map is carried out using product defect data at the time of implementation for 15 days, with 35 samples taken every day (**Table 8**).

Table 8. P control map calculation

Day	Date	Number of Production Samples (Pcs)	Number of Defective Products (Pcs)	Proportion of Defective Products	CL	UCL	Day
1	13-Feb	35	2	0,0571429	0,1142857	0,2756	-0,561
2	14-Feb	35	1	0,0285714	0,1142857	0,2756	-0,84
3	15-Feb	35	2	0,0571429	0,1142857	0,2756	-0,561
4	16-Feb	35	3	0,0857143	0,1142857	0,2756	-0,437
5	17-Feb	35	3	0,0857143	0,1142857	0,2756	-0,437
6	20-Feb	35	1	0,0285714	0,1142857	0,2756	-0,84
7	21-Feb	35	2	0,0571429	0,1142857	0,2756	-0,561
8	22-Feb	35	3	0,0857143	0,1142857	0,2756	-0,437
9	23-Feb	35	1	0,0285714	0,1142857	0,2756	-0,84
10	24-Feb	35	3	0,0857143	0,1142857	0,2756	-0,437
11	27-Feb	35	1	0,0285714	0,1142857	0,2756	-0,84
12	28-Feb	35	3	0,0857143	0,1142857	0,2756	-0,437
13	01-Mar	35	3	0,0857143	0,1142857	0,2756	-0,437
14	02-Mar	35	1	0,0285714	0,1142857	0,2756	-0,84
15	03-Mar	35	1	0,0285714	0,1142857	0,2756	-0,84
TOTAL		525	30				

$$CL = 0.571 \tag{11}$$

$$UCL = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{35}} = 0.571 + 3\sqrt{\frac{0.571(1-0.571)}{35}} = 0.1748 \tag{12}$$

$$LCL = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{35}} = 0.571 - 3\sqrt{\frac{0.571(1-0.571)}{35}} = 0 \tag{13}$$

4.5.2 Calculation of control map

After Implementation The calculation of the C control map is carried out using product defect data at the time of implementation for 15 days, with 35 samples taken every day (**Table 9**).

Table 9. C control map calculation

Day	Date	Number of Production Samples (Pcs)	Number of Defective Products (Pcs)	Proportion of Defective Products	CL	UCL
1	05-Okt	35	3	8	16,485	0
2	06-Okt	35	1	8	16,485	0
3	09-Okt	35	3	8	16,485	0
4	10-Okt	35	3	8	16,485	0
5	11-Okt	35	2	8	16,485	0
6	12-Okt	35	3	8	16,485	0

Day	Date	Number of Production Samples (Pcs)	Number of Defective Products (Pcs)	Proportion of Defective Products	CL	UCL
7	13-Okt	35	3	8	16,485	0
8	16-Okt	35	2	8	16,485	0
9	17-Okt	35	3	8	16,485	0
10	18-Okt	35	1	8	16,485	0
11	19-Okt	35	2	8	16,485	0
12	20-Okt	35	3	8	16,485	0
13	23-Okt	35	1	8	16,485	0
14	24-Okt	35	3	8	16,485	0
15	25-Okt	35	2	8	16,485	0
TOTAL		525	35			

$$CL = 2.33 \quad (14)$$

$$UCL = \bar{c} + 3\sqrt{\bar{c}} = 8 + 3\sqrt{8} = 6.916 \quad (15)$$

$$LCL = \bar{c} - 3\sqrt{\bar{c}} = 8 - 3\sqrt{8} = 0 \quad (16)$$

4.5.3 Calculation of DPMO and sigma level

After Implementation Calculation of the Defects per Million Opportunities (DPMO) value and sigma level after implementation is done after the control map calculation is complete (Table 10). The DPMO value and sigma level obtained will then be compared with the DPMO value and sigma level before implementation, by calculating the DPU value and DPO value first:

- The number of defects in production results after implementation is 35.
- The number of units or samples used in research after implementation is 525.
- The number of opportunities or opportunities for defects of 4, namely torn cardboard, printing errors, inconsistent colors and moisture.

$$DPU = \frac{defect}{unit} = \frac{35}{525} = 0.067 \quad (17)$$

$$DPO = \frac{defect}{unit\ x\ opportunity} = \frac{35}{525\ x\ 4} = 0.016 \quad (18)$$

$$DPMO = DPO\ x\ 1{,}000{,}000 = 0.016\ x\ 1{,}000{,}000 = 16{,}000 \quad (19)$$

$$Sigma\ level = normsinv\left(1 - \frac{DPMO}{1{,}000{,}000}\right) + 1.5 = normsinv\left(1 - \frac{16{,}000}{1{,}000{,}000}\right) + 1.5 = 3.670 \quad (20)$$

Table 10. Comparison of DPMO value and sigma level

Comparison	DPMO	Sigma Level
Before Implementation	42.900	3,195
After Implementation	16.000	3,67
Difference	26.900	0,475

5 Conclusion

The most common type of defect based on the Pareto diagram is a torn cardboard defect with a percentage of 59.9%. The two main causes of failure identified based on the highest RPN values are blunt mold cutting machines (RPN value 336) dirty printing machines

(RPN value 280) and lack of temperature and humidity control in the production area (RPN value 252). Some suggestions for improvement submitted to the company include Reducing the cutting capacity of cardboard molds, conducting regular cleaning with cleaning tools and improving the SOP for Factory Environmental Monitoring. After the implementation of the proposed improvements, there was a decrease in the DPMO value, from 42,900 to 16,000. The sigma level increased from 3.195 to 3.670. This shows that the company managed to reduce the number of defects without eliminating them completely, so that it can still meet customer satisfaction.

References

1. Mittal, P. Gupta, V. Kumar, A. Al Owad, S. Mahlawat, and S. Singh, "The performance improvement analysis using Six Sigma DMAIC methodology: A case study on Indian manufacturing company," Heliyon, vol. 9, no. 3, p. e14625, 2023, doi: 10.1016/j.heliyon.2023.e14625.
2. C. Sithole, I. Gibson, and S. Hoekstra, "ScienceDirect Evaluasi penerapan desain six sigma untuk teknologi manufaktur aditif logam," vol. 100, no. 2021, pp. 798–803, 2023.
3. A. Zhafira and R. Fitriana, "Quality Improvement and Waste Minimization in The Production Process of 450 MM Jacking Pipe Using the Lean Six Sigma Method," pp. 1069–1082, 2023, doi: 10.46254/ap03.20220211.
4. P. Fithri, "Six Sigma Sebagai Alat Pengendalian Mutu Pada Hasil Produksi Kain Mentah Pt Unitex, Tbk," J@ti Undip J. Tek. Ind., vol. 14, no. 1, p. 43, 2019, doi: 10.14710/jati.14.1.43-52.
5. A. Z. Al Faritsy and Angga Suluh Wahyunoto, "Analisis Pengendalian Kualitas Produk Meja Menggunakan Metode Six Sigma Pada PT XYZ," J. Rekayasa Ind., vol. 4, no. 2, pp. 52–62, 2022, doi: 10.37631/jri.v4i2.707.
6. E. Afriliano, S. T. S. L. A, and K. Kiswandono, "Analisis Pengendalian Kualitas untuk Mengurangi Kuantitas Kecacatan Produk (Studi Kasus pada Home Industry Tahu Jaya, Turen, Malang)," J. Mhs. Tek. Ind., vol. 4, no. 2, pp. 188–195, 2021.
7. Nailah, A. Harsono, and G. P. Liansari, "Usulan Perbaikan untuk Mengurangi Jumlah Cacat pada Produk Sandal Eiger S-101 Lightspeed dengan Menggunakan Metode Six Sigma," J. Online Inst. Teknol. Nas., vol. 2, no. 2, pp. 256–267, 2014.
8. D. Cesaron and Tandianto, "Penerapan Metode Six Sigma Dengan Pendekatan Dmaic Pada Proses Handling Painted Body Bmw X3 (Studi Kasus: Pt. Tjahja Sakti Motor)," J. PASTI, vol. IX, no. 3, pp. 248–256, 2019.
9. I. Mayusda, "Quality Improvement of Tin Ingot Product Using Six Sigma Method at PT Timah Tbk," Opsi, vol. 16, no. 1, p. 121, 2023, doi: 10.31315/opsi.v16i1.7434.
10. A. Bakhtiar, B. R. Dzakwan, M. E. Br Sipayung, and C. A. Pradhana, "Penerapan Metode Six Sigma di PT Triangle Motorindo," Opsi, vol. 13, no. 2, p. 113, 2020, doi: 10.31315/opsi.v13i2.4066.
11. H. Sirine, E. P. Kurniawati, S. Pengajar, F. Ekonomika, D. Bisnis, and U. Salatiga, "PENGENDALIAN KUALITAS MENGGUNAKAN METODE SIX SIGMA (Studi Kasus pada PT Diras Concept Sukoharjo)," AJIE-Asian J. Innov. Entrep., vol. 02, no. 03, pp. 2477–3824, 2017, [Online]. Available: http://www.dirasfurniture.com
12. W. Kurniawan, "Mengurangi Tingkat Kecacatan Pada Proses Produksi Pipa API 14 Inch di PT Bakrie Pipe Industries," J. Tek. Ind., no. Tingkat Kecacatan Pada Proses Produksi Pipa, pp. 1–8, 2016.

13. R. Fitriana and N. Anisa, “Perancangan Pebaikan Kualitas Produk Baut dan Sekrup Menggunakan Metode Six Sigma dan Data Mining di PT. A,” J. Tek. Ind., vol. 9, no. 1, pp. 46–53, 2019, doi: 10.25105/jti.v9i1.4786.
14. P. Moengin, R. Fitriana, and B. Ramadhan, “Perancangan Sistem Pendukung Keputusan untuk Pengendalian Kualitas pada Departemen Blow PT.D,” J. Tek. Ind., vol. 7, no. 3, pp. 188–207, 2017.
15. S. Harianto, E. Nursanti, and D. Indra Laksmana, “Aplikasi Metode Six Sigma Untuk Peningkatan Kualitas Dan Penjualan Kerajinan Cor Kuningan Tradisional Majapahit MojokertoYang Ramah Lingkungan,” J. Teknol. Dan Manaj. Ind., vol. 6, no. 1, pp. 21–26, 2020, doi: 10.36040/jtmi.v6i1.2626.
16. F. Ahmad, “Six Sigma Dmaic Sebagai Metode Pengendalian Kualitas Produk Kursi Pada Ukm,” Jisi Um, vol. 6, no. 1, p. 7, 2019, [Online]. Available: https://jurnal.umj.ac.id/index.php/jisi/article/view/4061
17. W. Kurniawan, “Sistem Manajemen Keamanan Pangan ISO 22000 Untuk Industri Yang Berhubungan Dengan Pangan,” J. Tek. Ind., vol. 1, no. 2, pp. 155–160, 2011, doi: 10.25105/jti.v1i2.7002. [18] M. Arifin and H. H. Supriyanto, “Aplikasi Metode Lean Six Sigma Untuk Usulan Improvisasi Lini Produksi Dengan Mempertimbangkan Faktor Lingkungan,” J. Tek. ITS, vol. 1, no. ISSN: 2301-9271, pp. A477–A481, 2012.
18. T. S. Dewayana, D. Sugiarto, and D. Hetharia, “Model Pemilihan Industri Komponen Otomotif Yang Ramah Lingkungan,” J. Tek. Ind., vol. 3, no. 3, pp. 208–216, 2013, doi: 10.25105/jti.v3i3.1564.
19. T. G. Amran, T. SD, and O. Prasyudi, “Model Evaluasi Kinerja Vendor,” J. Tek. Ind., vol. 4, no. 2, 2014, doi: 10.25105/jti.v4i2.1550.