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Improving the Finishing Process of Food Packaging Products Using DMAIC Method

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Abstract

PT PP2 which is engaged in printing and packaging manufacturing has to provide good quality products and continue to make improvements to survive and win the competition. Currently, PT. PP2 produces a premium product which is a Food Packaging Product program from a company namely Target. Unfortunately, there were many defects found in the production area especially in the Finishing Process Section. Based on the historical data from August 2019, there were 184 pieces of defective products per shift. This study is conducted to reduce four main defects in the finishing process section of food packaging products which are Bending, Plastic Broken, Damaged Shrinkwrap, and PET Bumpy. The DMAIC methodology as a proven and well-known quality improvement method is selected for solving the problem escorting other methods or tools such as why-why analysis, brainstorming, Kaizen activities, and FMEA. The result of implementation shows that defects decreased by 9.05% (from 184 pieces to 21 pieces of defective products per shift) or from 10% down to 1.17%. With this achievement, PT PP2 can be meet the customer requirement and deliver the product within time. This study again also shows that DMAIC is one of the best choices in improving quality, especially in manufacturing industries.

Keywords: *Food Packaging Product, DMAIC Method, Plastic, Quality, FMEA*

Introduction

The quality of the product is very important for the company. The customer can assess how the company's performance from the quality and on-time delivery. In the supplier's business process, the customer will be committed to how the quality of the production product match based on the sample. If the supplier is not biased to fulfill both commitments, the customer will usually provide a penalty to the supplier, and this will greatly give a bad impact on the company.

Quality improvement is everyone’s job. It is not the responsibility of a certain person or functional area but includes operator, engineer, manager, marketer, staff until the president of the company (Besterfield, 2014). There are numerous concepts, systems, methods, tools in the quality improvement area that can help any organization to increase their quality of products and services. Some of them are PDCA, Kaizen, SPC, DMAIC, Six-sigma, ISO, TQC, TQM, and so on (Montgomery, 2013). However, the selection of methods, tools, and system heavily depends on the resource's capability. Sometimes the methods chosen are related to the technology currently used by the industry. Certainly, the advanced technology used will require high skillful employees and advanced methods for quality improvements.

One quality improvement concept that getting popular in many industries since has been introduced by Motorolla Inc. is Six-Sigma which uses the DMAIC (Define-Measure-Analyze-Improve-Control) methodology (Rathore & Patidar, 2021). Rathore and Patidar concluded that more research should be done in the application of DMAIC in the manufacturing and service sector, integration to other quality initiatives, and implementation strategies. More research should be conducted on user experiences of the six-sigma DMAIC methodology.

The various study has proceeded regarding the implementation of six-sigma DMAIC, some of them are for improving online shop service quality (Devina & Aritonang, 2013), reducing pain bucket defective (Fransiscus et al., 2014), reducing cloths defect in a clothing company (Tjandra et al., 2018), improving bank account opening process at Palestine Islamic Bank (Al-Refai, 2021), combining with value stream mapping for service quality improvement at automotive service in Indonesia (Fathurohman et al., 2021), improving discharge process in hospital (Fazaeli et al., 2021), showing how the university and educational institutions can get benefit from DMAIC for cost-saving an increasing quality and performance (Fazaeli et al., 2021), productivity improvement of the document verification process (Triana, 2021), integrated capacity planning (Lopena et al., 2021), integrating undergraduate and graduate course in engineering technology and engineering management courses (Lee & Furterer, 2021). Prahara and Nawanglupi also utilized DMAIC combine with change management for reducing defective products, shoterter lead time, and improving worker awareness to their working environment (Prahara & Nawangpalupi, 2021).

PT. PP2 is one of the packaging companies in Cikarang, Indonesia. There are three types of products manufactured by PT. PP2, namely packaging toys for Barbies and Hotwheels owned by PT Mattel Indonesia, milk packaging Anlene, Boneto, etc. owned by PT Fonterra Brands Manufacturing Indonesia, and packaging for gifts owned by Target Brands Inc. Among three customers of PT PP2, only products for Target Brands Inc. are exported or sent directly to the United States. Products that are produced are Flat Box Packaging, Rigid Box Packaging, and Rigid Box Food Packaging. Rigid Box Food Packaging is a type of printed box packaging using board material coated with paper that has been printed and functions as a food container. There are several processes to produce rigid box food packaging, namely printing, die-cut, joint, and finishing. The final process for this product is finishing, which will then be inserted directly into the master carton. After completion, the product will be brought to the warehouse.

Especially for Food Packaging, there are certain requirements before the product can be put into the master carton. That is the UV machine process so that the product is sterile from bacteria and germs, and the product is wrapped in plastic using a wrapping machine. The finishing process in PT. PP2 is very crucial. Unfortunately, due to current conditions, the rejects generated by the finishing process exceed the reject limits set by the customer. The rejection rate required by the customer for the finishing process is a maximum of 2% of the total product to be produced per shift. However, under current conditions, the rejects generated by the finishing process can reach almost 10% per shift. When compared to other processes, the finishing process contributes the most rejects, as proven when PT. PP2 creates a Pareto chart for defects in all processes.

Therefore, PT. PP2 must improve the process by reducing the reject rate in the finishing process. This study aims to improve the finishing process to reduce the reject rate by applying DMAIC as suggested by (Carroll, 2013) for a better improvement.

Methods

Based on initial observations, it was found that there were many defects in the finishing process at PT. PP2 so that further analysis is needed for the improvement. To address this issue, the DMAIC methodology and some additional tools will be used in each phase of DMAIC to help improve the finishing process.

DMAIC Methodology

DMAIC is a methodology for assisting continuous improvement programs in a company. The five-core methodology is the best way to solve projects sequentially based on problems to control the results of these projects. DMAIC is included as one of six sigma tools, but it also can be applied as a standalone quality improvement procedure or other process improvements (Shankar, 2009).

Define

The Define phase is the first step in the DMAIC methodology. This step aims to identify more specifically the background of the problem, resources, project timeline, project scope, and objectives. The tools for Define Phase are Voice of Customer (VoC), Critical to

Quality, Project Charter, and SIPOC Chart (Gasperz & Vontana, 2011).

Measure

Measurement is about gathering data or information regarding current conditions about the process that will be used as a baseline. This phase starts with collecting data and quantifying the problems so that each member can focus more on the project and not be disturbed by other activities The tools are used in the Measure phase are Flow charts, Process Analysis, and Pareto Chart. Kaizen activities such as Genba discussion are also applied (Carroll, 2013).

Analyze

The purpose of Analyze phase is to understand the cause-and-effect relationships in the current process. Through this phase, the significant root causes as input factors will be investigated. Several tools are used to define and identify the root cause of the problem. The tools for Analyze Phase are Why-why Analysis, Brainstorming, FMEA, and Fishbone Diagram (Montgomery, 2013).

Improve

Improvement is the phase where the improving activity will proceed. In this stage, activities are carried out that aim to improve the performance of the current process in order to get better results. Improvement efforts are made based on the findings obtained at the Analyze stage. The tools for Improve Phase are Failure Mode & Effect Analysis, Experiment Role Exhibit, and Testing Improvement.

Control

The control phase is the last step from DMAIC. The main purpose of this phase is to place controls on all those significant input factors that influence the output. This phase aims to maintain the success of the improvement efforts that have been carried out, namely by controlling the process after the improvement. The tools for Control Phase are Build in Quality and Check Sheet Inspection.

Result and Discussion

Data

Figure 1 shows the Pareto chart of the defect in the food packaging product process at PT. PP2. The figure shows that the finishing process has the highest reject rate than the other process. With the 80-20 methodology in Pareto chart, PT. PP2 opted for the finishing process as a priority improvement.

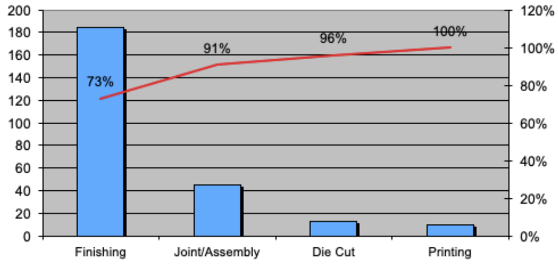

Figure 1. Pareto Chart of the defect in food packaging process at PT. PP2

Table 1 shows the data collection taken from internal quality in August 2019. It shows the number of defects per shift in the finishing process. Table 1 clearly shows that Bending and Plastic Broken have the highest number of defective.

Table 1. Internal inspection data at finishing process by QC

Process Name	**Finishing Process**			
Product Name	Rigid Box Food Packaging Product			
Process Owner	Nanang Kurniadi			
No	Defect		Numbers of Defect	
1	Bending		68	
2	Plastic Broken		52	
3	Damage Shrinkwrap		18	
4	PET Bumpy		18	
5	Miss Position		15	
6	Broken		6	
7	Improper Position Label		5	
8	Wrong Position in MC		2	
Date	Spv. Quality Inspector	Signature	Dept. Head of Quality	Signature
Aug-19	Anita		Stephan D.	

Analysis

Define Phase

Defining the problem means creating the problem statement based on the Voice of the Customer and is defined as Critical to Quality. VoC is a term used in the business world that is used to describe a process to know and understand the expectations, preferences, and dislikes of customers for the goods or services offered. VoC is gathered through internal meetings attended by several teams related to the manufacturing process of the product and also the General Manager.

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Table 2. VoC and CTQ for Food Packaging Product

VoC	*Customer Feel*	*Key Issues*	*CTQ Requirement*
I'm waiting one hour until two hours just for take the product in warehouse	Waiting too long for product inspection	Want to get the product faster or below 1 hour	The customer gets the product below 1 hour, so the product must be ready before the inspector come (Target per shift must be complete or closer to complete)
I am always find the bending defect. In this case is problem since last year. This very critical because about Function issues	The Bending product is too much, because about function issues	Reduce or remove the bending of the product (Reject)	Customer wants, during the inspection the finding of the bending reject is smaller than before
Until the DUPRO Session the reject rate is high (almost 10% from the target per shift)	Until the 10% of the total product that the customer order, the reject rate is high or the 10% from the 10% of the total product is reject (The customer maybe calling the competitor if PP2 cannot improve)	The reject rate is must be below than 10%	Customer wants the reject rate is below than 10% so the shipping window can be complete

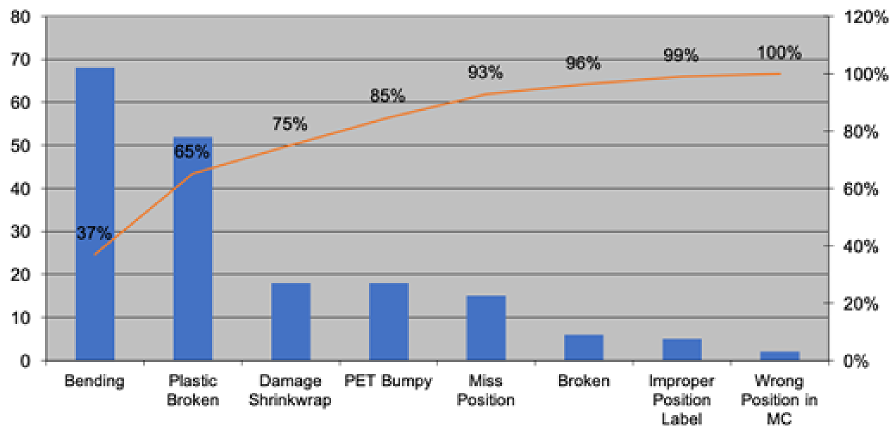

Figure 2. Pareto Chart of Defects at Finishing Process

The VoC listening process is proceeded in five steps: (1) listening to the customer (after customer did their during production inspection), (2) organizing and analyzing (internal meeting), (3) communicating the intelligence (create the group project), (4) execute the response (conduct the kaizen), (5) modify the listening process (take the action plan before final inspection). CTQ aligns the improvement with customer satisfaction requirements. Table 2 shows how this VoC information is translated into CTQ requirements while Table 3 exhibits the current SIPOC condition which reveals that there are 14 activities inside the finishing process.

Measure Phase

After defining this project based on Voice of Customer, then proceed with measuring the current condition in the finishing process. Based on the process analysis, it was found that there were four activities that resulted in the highest defects, namely placing the product in the WIP 1 area, sealing the plastic using a manual machine, placing the product in the WIP 2 area, and placing the product set in the wrapping machine. Table 4 summarizes the entire finishing process.

Figure 2 shows the Pareto Chart of defects at the finishing process, this chart explains the defect sequence from the largest to the smallest. By using the 80-20 method, four defects are prioritized for improvement and these defects will be analyzed later. The defects are Bending, Plastic Broken, Damage Shrinkwrap, and PET Bumpy. The four top defects derived from activities marked in red.

Figure 3. describes the flow diagram of food packaging products in the finishing process. This chart also reveals the impact when some processes fail. If there is a problem with the process, it will be rejected or reworked.

Figure 4 shows the layout of the current finishing process. In this process, the workforce is too much and still has a WIP area. With this layout, the process is not optimal. Therefore, some activities and positions must be rearranged for the better.

Table 3. SIPOC summary in the finishing process

SIPOC	Activity
Suppliers	Join Process
Input	WIP Large Top WIP Large Bottom WIP Small Top WIP Small Bottom
Process	Start point: Take the product in WIP area 1 Operation: 1. Sorting product 2. Input every product to UV machine 3. Assembly Top & Bottom Product 4. Assembly Small & Large Product 5. Put the product in WIP area 1 6. Input the product to plastic 7. Sealing plastic using manual machine 8. Put the product in WIP area 2 9. Piercing plastic using sharp tools 10. Input the product set to the wrapping machine 11. Inspect the product set 12. Labeling the product set Endpoint: Input the product to master carton
Output	Master Carton of Food Packaging Product
Customers	Warehouse

Table 4. Summary Data in Finishing Process

Type	
Man Power	16 worker
Average Cycle Time	9,786 seconds
Planning	1800 pcs
Defect/Shift	184 pcs
Percentage Defect per shift	10.22%

Analyze Phase

The team did the why-why analysis with the Gemba method on the second day of kaizen. When the team directly went to the production line, the team asked the people who have direct relations for making the product in the finishing process. The focus of Gemba is the fourth activity that bore the most defects. Usually, Gemba contains 3 to 5 questions, but it can be less or more, depending on the answer whether you have got the root cause or not.

Brainstorming is the closing in this kaizen event. All team members of kaizen share their idea about each root cause and find what department will be conducting the improvement based on the root cause analysis (Table 5). After conducting a why-why analysis and brainstorming, a Fishbone Diagram is applied to obtain conclusions from the root cause analysis. Table 6 is the result of a fishbone diagram related to the four major defects in food packaging products in the finishing process.

Improvement Phase

Based on the root causes found as shown in Table 6, the improvement plan will be initiated. In this phase, the tools used by the company are Failure Mode & Effect Analysis (FMEA) to determine an action plan for each root cause, Experiment Role Exhibit to determine who is responsible for each improvement, and lastly is Test of Improvement until it is found that the new improvement is succeeded or has an impact on the finishing processing. Table 7 shows the improvement planning.

The FMEA can identify risks related to options that must be addressed in the manufacturing system and implementation phase. This is so that the FMEA team can focus on determining the severity of the problem if it occurs or how often the problem occurs, and the last is the level for detecting problems. Table 8 is the result of FMEA. The tables shows that Bending and PET Bumpy defects have a high RPN rating that able to stop production because their RPN value is above 405. This means that the improvement process must be carried out as quickly as possible to avoid losses.

As for damage shrink, wrapping and broken plastic have a total value of 135-216, and both defects were at critical levels and need to be improved. FMEA can be used to analyze failure modes in both processes and products.

In this study, the FMEA used was the FMEA process. After knowing the RPN, the improvement will be based on why-why analysis and root cause analysis explained in Tables 5 and 6.

In the Experiment Role Exhibit, the step of each improvement was decided by the team project and selected PIC will handle the improvement activity. Possibly there is a situation where this PICs need help from several people who have certain expertise so that improvement can run well and according to plan. Table 9 shows the Experiment Role Exhibit for this project.

Testing improvement is to try the improvement plan that will be carried out according to FMEA. This stage is very important

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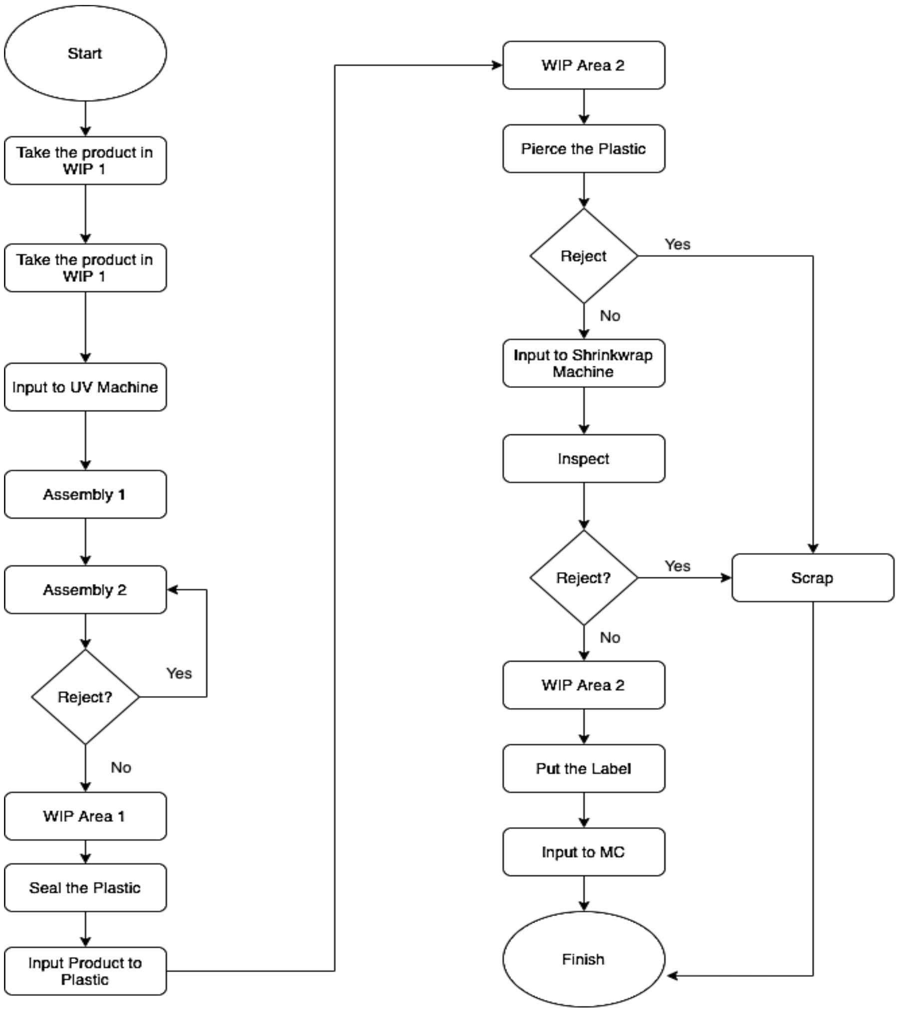

Figure 3. Food packaging product in Finishing Process

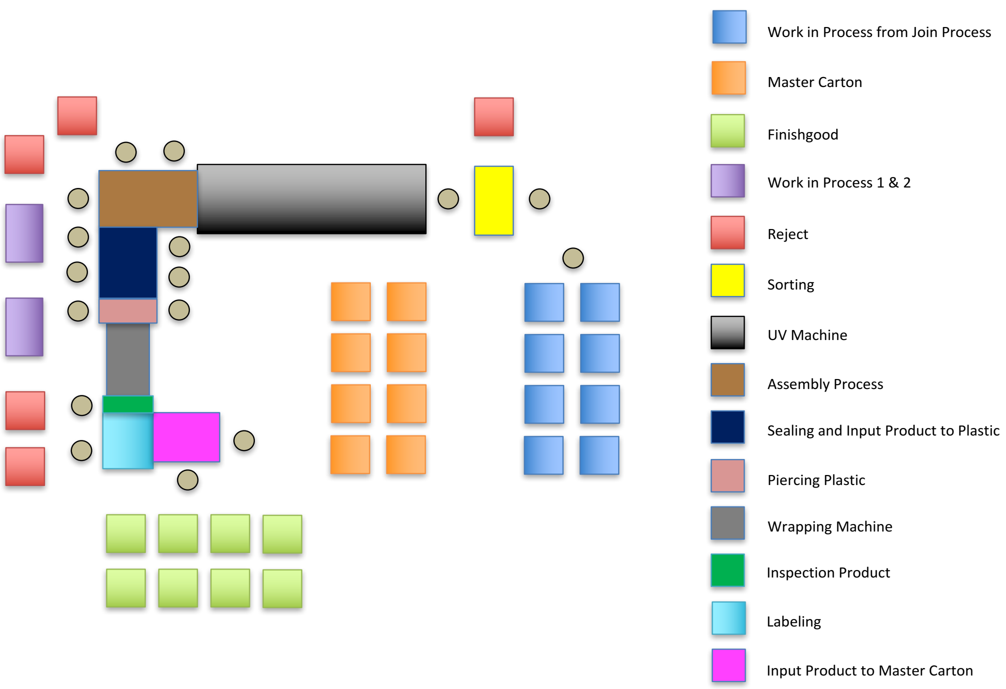

Figure 4. Current layout

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Table 5. Brainstorming for Potential Root Causes Activity

Problem Statement: High of reject rate in Finishing Process

Defect	***Activity***	***Potential Root Cause***	***Cause of Activity***	***R+ Department***
Bending	Input the product set to wrap machine	Using plastic roll material	Sealing plastic using manual machine	Product Engineering
	Input the product set to wrap machine	There is no standard for piercing the plastic	Piercing plastic using sharp tools	Industrial Engineering
	Input the product set to wrap machine	There is no standard setting for shrinkwrap machine that is suitable for the product	Input the product set to wrap machine	Mechanic & Industrial Engineering
	Put the product in WIP area 1 & 2	Process is not one piece flow	Put the product in WIP area 1 & 2	Industrial Engineering
Damaged Shrinkwrap	Input the product set to wrap machine	Lack of briefing and monitoring from supervisors and production leaders regarding product handling	Input the product set to wrap machine	Production Supervisor
	Input the product set to wrap machine	There is no standard setting for shrinkwrap machine that is suitable for the product	Input the product set to wrap machine	Mechanic & Industrial Engineering
	Input the product set to wrap machine	Using plastic roll material	Sealing plastic using manual machine	Product Engineering
PET Bumpy	Input the product set to wrap machine	There is no standard setting for shrinkwrap machine that is suitable for the product & Using the available PET material in the storage (not good material)	Input the product set to wrap machine	Mechanic & Industrial Engineering
Plastic Broken	Sealing plastic using manual machine	Using plastic roll material	Sealing plastic using manual machine	Product Engineering
	Sealing plastic using manual machine	Using plastic roll material available in storage (not good material)	Sealing plastic using manual machine	Product Engineering

Table 6. Summary of the Root Cause

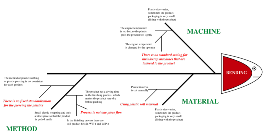
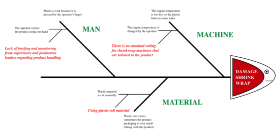
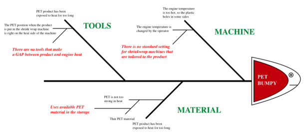
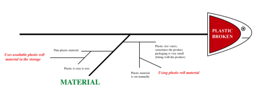
Production risk / Failure Mode	**Root Cause**
 Bending	There are variations in size because the sealing process uses a plastic roll
	The plastic piercing process is not consistent
	Shrinkwrap machine settings are often changed because there are no standards that are tailored to the product
	The process is not one piece flow because of the product buildup process that is stacked in the WIP area
 Damaged Shrinkwrap	Lack of briefing and monitoring from leaders and production supervisors regarding product handling
	The shrinkwrap machine settings are often changed because there is no standard that is adapted to the product
	There are variations in size because the sealing process uses a plastic roll
 PET Bumpy	Shrinkwrap machine settings are often changed because there are no standards that are tailored to the product
	Use thin PET material or make use of PET that is available in the storage
 Plastic Broken	There are variations in size because the sealing process uses a plastic roll
	Thin plastic material, because it only uses materials available in the storage

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Table 7. Improvement Planning

Production RISK / Failure Mode	Cause	Action Plan
Bending	There are variations in size because the sealing process uses a plastic roll	Change plastic sealing with buying the plastic that adjusts to the size of the product and change its thickness
	The plastic piercing process is not consistent	Making methods and tools to piercing the plastic sealing before entering the shrinkwrap machine on the trail by Industrial Engineering, Production Supervisor, and Product Engineering
	Shrinkwrap machine settings are often changed because there are no standards that are tailored to the product	Making the standard setting of the machine on the trail by Industrial Engineering, Mechanics, Production Supervisor, and Product Engineering.
	The process is not one piece flow because of the product buildup process that is stacked in the WIP area	Making Process Flow by analyzing the potential for better flow using existing tools by Industrial Engineering & Mechanics
Damaged Shrinkwrap	Lack of briefing and monitoring from leaders and production supervisors regarding product handling	Conduct briefings every day, before doing the production process and monitoring the product every hour
	The shrinkwrap machine settings are often changed because there is no standard that is adapted to the product	Making the standard setting of the machine on the trail by Industrial Engineering, Mechanics, Production Supervisor, and Product Engineering.
	There are variations in size because the sealing process uses a plastic roll	Change plastic sealing with buying the plastic that adjusts to the size of the product and change its thickness
PET Bumpy	Shrinkwrap machine settings are often changed because there are no standards that are tailored to the product	Making the standard setting of the machine on the trail by Industrial Engineering, Mechanics, Production Supervisor, and Product Engineering.
	Use thin PET material or make use of PET that is available in the storage	Changing the thickness of PET and with good quality plastic
Plastic Broken	There are variations in size because the sealing process uses a plastic roll	Change plastic sealing with buying the plastic that adjusts to the size of the product and change its thickness
	Thin plastic material, because it only uses materials available in the storage	Change plastic sealing with buying the plastic that adjusts to the size of the product and change its thickness

Table 8. FMEA at Finishing Process

Function / Process	Production RISK / Failure Mode	Cause	Effect	Current Controls	S	D	O	RPN
Finishing Process	Bending	There are variations in size because the sealing process uses a plastic roll	Rejection	Inspection after the shrinkwrap machine process uses L-shaped Jig	10	5	9	450
		The plastic piercing process is not consistent	Rejection	Inspection after the shrinkwrap machine process uses L-shaped Jig	10	5	9	450
		Shrinkwrap machine settings are often changed because there are no standards that are tailored to the product	Rejection	Inspection after the shrinkwrap machine process uses L-shaped Jig	10	5	9	450
		The process is not one piece flow because of the product buildup process that is stacked in the WIP area	Rejection	Inspection after the shrinkwrap machine process uses L-shaped Jig	10	5	9	450
	Damaged Shrinkwrap	Lack of briefing and monitoring from leaders and production supervisors regarding product handling	Reprocess	Visual inspection after the shrinkwrap machine process	8	3	9	216
		Settingan mesin shrinkwrap sering diubah-ubah karena belum ada standard yang disesuaikan dengan product	Reprocess	Visual inspection after the shrinkwrap machine process	8	3	9	216
		There are variations in size because the sealing process uses a plastic roll	Reprocess	Visual inspection after the shrinkwrap machine process	8	3	9	216
	PET Bumpy	Shrinkwrap machine settings are often changed because there are no standards that are tailored to the product	Rejection	Visual inspection by QC with random sampling at the end of the process	10	9	9	810
		Use thin PET material or make use of PET that is available in the storage	Rejection	Visual inspection by QC with random sampling at the end of the process	10	9	9	810

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Plastic Broken	There are variations in size because the sealing process uses a plastic roll	Reprocess	Visual inspection after the sealing process and after the shrinkwrap machine	5	3	9	135
	Thin plastic material, because it only uses materials available in the storage	Reprocess	Visual inspection after the sealing process and after the shrinkwrap machine	5	3	9	135

Table 9. Experiment Role Exhibit for Each Improvement

Department: Production	**Location: Finishing Process**	**Date: 9 September 2019**	**Product: Food Packaging Product**	
Phase for Action:	**First**	**Second**	**Third**	**Fourth**
Action Plan:	Change plastic sealing with plastic purchases that adjust to the size of the product			
First				
Role	Responsibility	R+	Status	
Product Engineering Staff & Admin	Determine new plastic sizes and place new plastic orders	Tri Handoko & Meika	Done	
Second				
Role	Responsibility	R+	Status	
Product Engineering Staff & Production Supervisor	Trial the production line with new plastic	Tri Handoko	Done	
Third				
Role	Responsibility	R+	Status	
Industrial Engineering Team	Analyzing every hour and every shift is the new product quality more optimal or not	Dimas Rangga Arya	Done	
Forth				
Role	Responsibility	R+	Status	
Product Engineering Manager	Receive and review reports from the Industrial Engineering team in comparison with the reject trail and make a standardization of plastics for food packaging products	Kumoro	Done	

because it relates to improvements that will be carried out in the finishing process and all results of Testing Improvement will be assessed by management. The improvement can be seen in Figures 5, 6, 7, 8, 9, 10, and 11.

Figure 5. Shrink Wrap machine setting

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Figure 6. Jig before (left) and after (right) the improvement

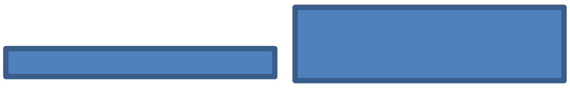

Figure 7. The thickness PET of the Product before (left) and after (right) the improvement

Figure 8. Plastic Roll (left) and Plastic Sheet (right) that are used before and after the improvement.

PET Bumpy Defect Improvement

The equipment image in Figure 5, is the best setting that can prevent the product from defect. Heat temperature of 89 degrees Celsius and a speed of 140m/h have been chosen as the optimum values.

Figure 6 is an improvement on Jig to prevent PET products from being directly affected by heat in the machine. Around 16pcs of holes were made so that the heat of the machine is not directly affected by PET, to reduce the potential for PET Bumpy. With this Jig, the operator who receives the product after the shrink wrap process can do an inspection, without looking in detail. Because, after receiving the product the operator must release the Jig which will accidentally see how the condition of PET. Therefore, this can eliminate inspection activity after shrinking the machine and combining it with the label operator. This briefing helps in reducing rejects because they relate to activities that are not directly understood by the operator. That how to handle products properly is very influential on product quality. This improvement is also related to the change in PET thickness of the product from 17 microns in PET size to 23 microns in PET size.

Figure 7 shows an illustrated image of improvement in PET thickness. Previously it was 17 microns in PET size, and after improvement was 23 microns in PET size. It is a 30% increase to the previous thickness.

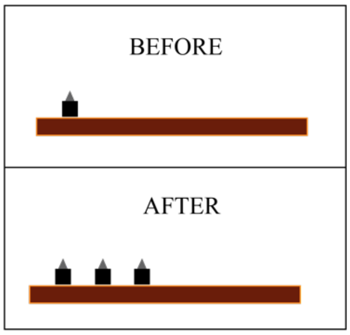

Figure 9. Comparison of Jigs for piercing plastics before and after the improvement

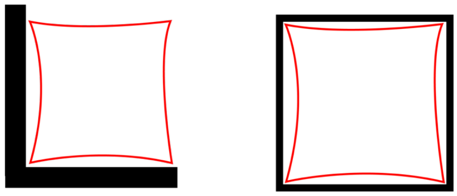

Figure 10. Jig detection for bending defect before (left) and after (right) the improvement

Bending & Plastic Broken Defect Improvement

Figure 8 is the result of improvement from one root cause, which is replacing plastic sealing roll into plastic that is under the product size. The thickness of this plastic is also different. In the previous condition, the shrink-wrap material used is 12 microns in roll size. Meanwhile, to reduce the defects, the material of shrink-wrap thickness is changing to 15 microns in sheet size.

Figure 9 shows plastic hole punch Jig changes. Previously it only used one awl, and changed it to three awls, the method was different. In the previous process, the way to pierce it was by doing four stitches on the upper side and four stitches on the lower side. The improvement trial is to do one stitch on the top, one stitch on the bottom, one stitch on the right, and one stitch on the left. Piercing activities that previously did eight total stitches, and by improvement only did four stitches.

Figure 10 is a trial of improvement to detect the bending defect. Jig was previously L-shaped, where the inspection process must rotate the product to check whether it is bending or not. Trial improvement that has been done is to use a box-shaped Jig, with this trial the inspection process will be faster. By entering the product right in the hole of the box, the operator can see whether it is bending or not.

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With this process, the improvement team can eliminate the inspection operator process and merge it with the label operator.

Damage Shrinkwrap Defect Improvement

Figure 11 is an improvement by Daily briefing about how to handle the product without damage. This is also important since one of the root causes is a lack of attention and briefing to the leaders, operators, and helpers. This briefing is commonly referred to as P10M (10 Minutes Meeting) Ten Minutes Meting. So that the operator can continue to remember how to hold the product correctly. This P10M continues to be carried out daily with control conducted every hour by the production supervisor.

Figure 11. Briefing with the Operators About Handling the Product

Control Phase

After getting the improvement the company needs to control by internal quality inspection to know the advantages and the disadvantages. So, the management will decide whether each improvement must be standardized or development still needs to be done. Figure 12 is the check sheet form for the inspection.

The last phase of DMAIC is the control phase after doing the improvement the company must control and check the improvement, whether is it good or not for the PT.PP2. In this phase, the team uses Build of Quality to ensure that production produces good quality after making improvements and to ensure that the improvements made are sustainable.

Build-in Quality for Finishing Process

Build-in Quality is a way to tighten inspections in the production process. This inspection is supported by the quality department itself by conducting hourly inspections by QC inspectors. After conducting an inspection, the inspector report directly with the Quality Manager, and the Quality Manager will review directly with the project team daily. Whether the improvement is going well or not.

Check Sheet Inspection per Hour

The Check Sheet in Figure 12 is a new form for conducting internal inspections. In this form, the Quality Inspector is directly confronted by the Quality Manager at the end of shift 1, and the one who will review directly is the Improvement team. So, the scope of this inspection is greater than the inspection of ordinary products. With the implementation of this inspection, the improvement team hopes that the improvements that have been made can be controlled and keep going well and correctly.

Summary

To summarize, there are some changes in process, manpower, method, and material. These are some of the changes related to the improvement produced by this project which will be proposed to management.

Table 10. New SIPOC

<table>
<tr><th>SIPOC</th><th>Activity</th></tr>
<tr><td>Suppliers</td><td>Join Process</td></tr>
<tr><td>Input</td><td>WIP Large Top
WIP Large Bottom
WIP Small Top
WIP Small Bottom</td></tr>
<tr><td>Process</td><td>Start point: Input every product to UV machine
Operation:
1. Assembly Top & Bottom Product
2. Assembly Small & Large Product
3. Input the product to plastic
4. Piercing plastic using sharp tools
5. Input the product set to the wrapping machine
6. Labeling the product set
Endpoint: Input the product to master carton</td></tr>
<tr><td>Output</td><td>Master Carton of Food Packaging Product</td></tr>
<tr><td>Customers</td><td>Warehouse</td></tr>
</table>

SIPOC after improvement

Table 10 explains the changes in SIPOC after improvement. By eliminating some activities before improvement, then the new

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SIPOC consists of 8 activities is in the process step.

Table 11. The Comparison Number of Defects

No	Defect	Before	After
1	Bending	68	2
2	Plastic Broken	52	4
3	Damage Shrinkwrap	18	1
4	PET Bumpy	18	1
	Total	156	8

Based on the Bar Chart in Figure 13 shows that the defect rate has reduced significantly, the 4 biggest defects have been greatly reduced, even the maximum defect shift for each defect is only 5 pcs. When viewed from the total number of defects this is so much better.

Figure 14 shows the proposed new layout change, with some of the changes that were discussed in the previous stage. Compared to the previous layout Figure 4 the improvement made is to clear the WIP area and change transportation for the assembly process to use a conveyor.

Project Name: Improvement at Finishing Process for Rigid Box Food Packaging

Check Sheet for Control the Improvement

Name of Data Recorder:

Location: Finishing Process

Hour: 7PM - 8PM

Activities	Defects								TOTAL
	Miss Position	Bending	Plastic Broken	Broken	Damage Shrinkwrap	PET Bumpy	Improper Position Label	Wrong Position in MC	
Input every product to UV machine									
Assembly Top & Bottom Product	1								1
Assembly Small & Large Product	1								1
Input the product to plastic									
Piercing plastic using sharp tools				1					1
Input the product set to wrapping machine		2			1				3
Labeling the product set							1		1
Input the product set to master carton								1	
TOTAL	2	2		1	1		1	1	**7**

Figure 12. Check sheet example

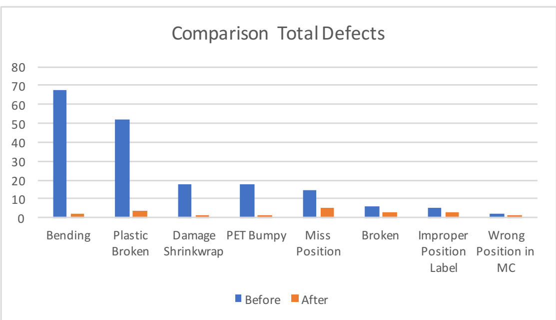

Figure 13. Bar Chart Before and After Improvement

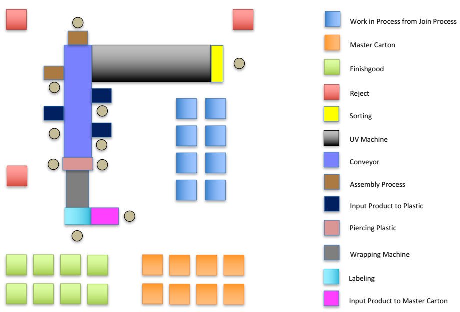

Figure 14. The Layout Improvement for Finishing Process

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The Standardization of Improvements

With good improvement results, PT PP2 management should have agreed to implement it in the finishing process so that changes are made. Figure 15 is an example of work instruction that will be used in the improvement process that is acceptable to the General Manager of PT. PP2.

Cost Comparison of Before & After Improvement

Table 12 is the cost comparison of before and after improvement. The comparison involves the cost of people, electricity, and the machine.

The cost that will be required after the improvement is much lower, even with the repair it can be very profitable for the company. The cost reduction is around 46%.

It can be seen that from a comparison to previous data, PT PP2 can save more as much as Rp. 79,329,295 and can be multiplied for the third until fourth months based on Table 13.

Table 12. Cost comparison before and after improvement (in IDR)

Before		
Manpower	16 Manpower	65,600,000
	16 Manpower for extra time 3 hours per shift	43,200,000
Electricity	Mesin UV	23,109,660
	Mesin Wrapping	11,554,830
	Sealing	2,773,159
Material	6 Roll Plastic Sealing	27,000,000
Total		173,237,649

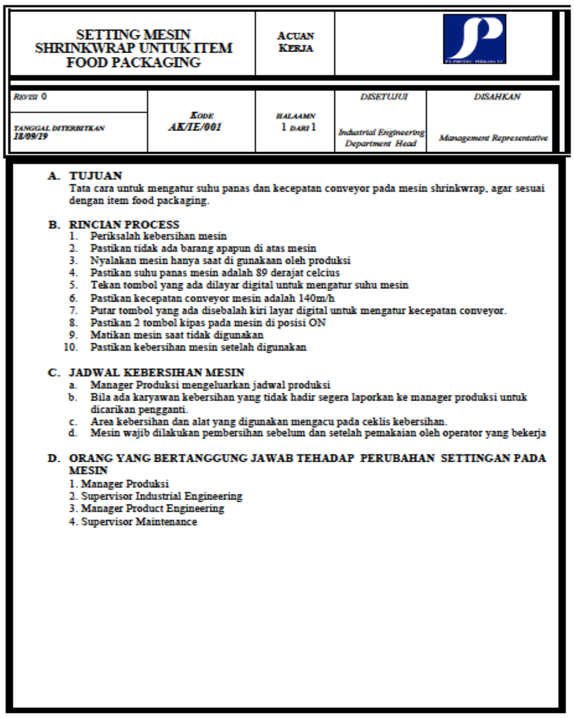
After		
Manpower	10 Manpower	41,000,000
Electricity	Mesin UV	23,109,660
	Mesin Conveyor	6,470,705
	Mesin Wrapping	11,554,830
	Sealing	2,773,159
Material	3 Pack Plastic Sealing	9,000,000
Total		93,908,354

Table 13. The Benefits Cost until the production complete (in IDR)

1st Month	2nd Month	3rd Month	4th Month
79,329,295	158,658,590	237,987,886	317,317,181

Comparison of the Result with the Objective of the Project

Table 14 shows that the company can reduce the percentage of all defects in the finishing process from a 10.22% defect rate with a 184 pcs defect to a 1.17% defect rate with a 21 pcs defect or PT. PP2 succeeded in reducing the defect by 9.05% or improved by 88.55%. The company succeeded to reduce all defects below 2% as required by the customer. Besides that, PT. PP2 also succeeded in reducing the number of operators from 16 Operators / Man Power, to 10 Operators / Man Power.



SETTING MESIN SHRINKWRAP UNTUK ITEM FOOD PACKAGING	ACUAN KERJA			
REVISI 0 / TANGGAL DITERBITKAN 18/09/19	KODE AK/IE/001	HALAAMN 1 DARI 1	DISETUJUI Industrial Engineering Department Head	DISAHKAN Management Representative

A. TUJUAN
Tata cara untuk mengatur suhu panas dan kecepatan conveyor pada mesin shrinkwrap, agar sesuai dengan item food packaging.

B. RINCIAN PROCESS
1. Periksalah kebersihan mesin
2. Pastikan tidak ada barang apapun di atas mesin
3. Nyalakan mesin hanya saat di gunakaan oleh produksi
4. Pastikan suhu panas mesin adalah 89 derajat celcius
5. Tekan tombol yang ada dilayar digital untuk mengatur suhu mesin
6. Pastikan kecepatan conveyor mesin adalah 140m/h
7. Putar tombol yang ada disebalah kiri layar digital untuk mengatur kecepatan conveyor.
8. Pastikan 2 tombol kipas pada mesin di posisi ON
9. Matikan mesin saat tidak digunakan
10. Pastikan kebersihan mesin setelah digunakan

C. JADWAL KEBERSIHAN MESIN
a. Manager Produksi mengeluarkan jadwal produksi
b. Bila ada karyawan kebersihan yang tidak hadir segera laporkan ke manager produksi untuk dicarikan pengganti.
c. Area kebersihan dan alat yang digunakan mengacu pada ceklis kebersihan.
d. Mesin wajib dilakukan pembersihan sebelum dan setelah pemakaian oleh operator yang bekerja

D. ORANG YANG BERTANGGUNG JAWAB TEHADAP PERUBAHAN SETTINGAN PADA MESIN
1. Manager Produksi
2. Supervisor Industrial Engineering
3. Manager Product Engineering
4. Supervisor Maintenance

Figure 15. Work instruction for setting the Shrink Wrap machine

Table 14. Before and after improvement project improvement

Before				
Man Power	Average (sec)	Planning (pcs)	Defect/ Shift	Percentage Defect per shift
16	9.786	1800	184	10.22%
After				
Man Power	Average (sec)	Planning (pcs)	Defect/ Shift	Percentage Defect per shift
10	9	1800	21	1.17%

Compared to a study done by (Fathurohman et al., 2021) that speed-up maintenance service by 53% and improve sigma level from 1.96 to 3.80, research done by (Fazaeli et al., 2021) show an improvement by more than 50% waiting time reduction for the patients receive medical services, and also study by (Al-Refai, 2021) that DMAIC application able to reduce the average time of opening a new bank account by 61.4%, our study showed that DMAIC was able to improve the process significantly by 88.55% in this case.

Conclusion

The root causes that caused the process defect in the finishing process for bending are variation in shrink-wrap size, wrapping machine was not optimal, the method for piercing the plastics has not yet been standardization, the Jig in the finishing process is not optimal yet, and the lack of the understanding for handling the product from the operator. PT. PP2 can reduce the Bending defect from 68 pcs to be 2 pcs Bending defects.

Trail improvements undertaken include making a more efficient Jig, setting the temperature of the engine, setting a standard piercing method, changing the manual process flow into a conveyor to eliminate the WIP process, and the production will run one-piece flow. PT. PP2 can reduce the reject for Rigid Box Food Packaging product from 10% defect per shift to be 1,17% defect per shift.

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