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Maintaining the Quality of Tuna of Aceh for the Japanese Export Market

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This study aims to reduce the number of Tuna processing in Aceh products that will be exported to Japan. The decline in the defect level of this product is a critical point to reduce the number of customer complaints so that business continuity with trading partners abroad is maintained. The main fish products export from Aceh are fresh tuna loin fish. There are often complaints from customers in export destination countries because the fresh Tuna Loin products received by them are not up to standard. The color of the tuna is less red and tends to be pale, the fish looks less fresh, and the texture of the fish is broken and mushy. To solve this problem, the PDCA method is used, which consists of Planning by doing observation in the fish processing unit starting from the reception of the fish until the final product processing. It does by improving the weakness of the process such as tightening the time of purchasing fish, adding fish containers, improve cooling room temperature, standardization of production process providing dry ice inside the packaging to maintain the quality of loin. Control by evaluating the number of complaints and compare it to the previous one. Action by doing standardization of the process and publish Standard Operation Procedures booklet as a guide to be followed during the production stage. This effort was supported by the use of 7 quality control tools, namely check sheet, histogram, Pareto chart, control chart, cause and effect diagram, and FMEA. There was also one expert Tuna from Japan is staying in Aceh to ensure the quality of Tuna delivered in accordance with Japanese market expectations. Improvements have been made to reduce the number of defects and complaints from customers. The number of defects items, both the color and texture of Tuna meat as of July to August 2018 felt by 45% and 42% respectively compare to the period of March-May 2018. Consequently the number of fresh tuna loin complaints has also decreased because all of the loin shipped to them were already in good quality. This research only takes samples on the processing of Tuna fishermen product in in Banda Aceh, and only for Japanese market. Further research suggested to cover area beyond Aceh and also for other countries apart from Japan, for export destination. Research on improving the quality of Tuna with PDCA method as long as the author's knowledge has never been done in Aceh because the export of Loin Tuna Aceh to Japan has only recently developed.

Keywords: *Quality Control, PDCA, Tuna Loin, Product Defect, FMEA, Cold Chain, Supply Chain, Export Market, Quality Improvement, Japan Market*

JEL Classification: *M11, M31*

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1. Introduction

Industrial development objectives, including the Tuna processing industry, are for the welfare of the people involved in this industry chain, ranging from Tuna Fishermen, Bench Stools / Collectors, Large Traders, Processors to Tuna Exporters.

The amount of benefits gained by each level of participants in the Tuna industry is highly dependent on the selling price of the Tuna itself (Jiang et al., 2016). The main determinant factor for the high and low selling prices received at each level, is very dependent on how much the buyer willing to pay the Tuna Loin from Aceh. At the same time, the desire of buyers to pay high prices depends on how good is the quality of tuna they can get (Maiti and Giri, 2015). In Aceh, the Tuna supply chain consists of 5 levels of the distribution chain, namely fishermen, collectors, wholesalers, processors and exporters. In many cases, the processor also functions as an exporter (Chan et al., 2017).

Efforts to increase the amount of tuna exported must be supported by an increase in the quantity, quality and added value of tuna itself (Wardono et al., 2015). Generally, companies that export tuna processed products have several challenges in running their business, including competition with similar companies, especially foreign companies, demands for the fulfilment of product quality standards that have been set for export markets, export capabilities with quantity according to buyer's request (Carballo et al., 2018). Thus, companies that want to survive must be able to produce quality products that are in line with the demands of consumers.

Low quality tuna will certainly be rejected by the buyer and cause great losses. For example in the period March - May 2018, only from one supplier there was no less than 426 Kg of defect product, either not passed the final QC in the processing or rejected by the buyer. If it was assumed that the selling price of exporters was USD 10 / kg then there was USD 4,260 of losses suffered by the Aceh Tuna industry due to the low quality of Tuna Loin produced (UD Nagata Tuna, 2018).

Seeing the importance of quality control at the processor level, may previous researchers have made a lot of studies in this field, to see what variables were the cause of the decline in the quality of Tuna Loin. In maintaining the quality of the products produced, it requires continuous quality improvement (Moin et al., 2018). Quality control is carried out to produce quality product that is in line with the expected demands (Mitra, 2016). Control techniques and product quality improvement can be analyzed using the Six Sigma method (Jairaman et al., 2017). Other researchers use the PDAC technique which stands for Plan, Do, Act and Control to make sure the production process has zero defect (Moen and Norman, 2006).

Although many researchers have examined this problem, for small-scale processing like the one in Banda Aceh, no one has examined it yet. Because this small-scale processing has more human power. In other words, Tuna processing is still be done manually. So there will be more variables that must be controlled compare to large-scale processing that has been run automatically (Nallusamy et al., 2015). Research on improving the quality of Tuna with PDCA method as long as the author's knowledge has never been done before in Aceh

To minimize the causes of failure in maintaining product quality, the authors added Failure Mode and Effects Analysis (FMEA) production monitoring equipment, which was adopted from the automotive production quality control process at Ford Motor Company (Luo et al., 2015). FMEA is a structured procedure to identify and prevent as many modes of failure as possible during the production process (Dobryden et al., 2017). The decline in the defect level of this product is a critical point to reduce the number of customer complaints in order to maintain the business continuity (Birim et al., 2016).

The findings from this study can later be used as a model for the development of small-scale tuna industry that can be used and generalized to similar companies in all coastal areas of Indonesia.

2. Literature Review

2.1. Understanding Quality

Pianta et al. (2016), define the quality as a fulfilment of requirements by minimizing the damage that may arise or known as zero defect standard. Whereas Goetsch et al. (2014) came up with a broader definition of quality. The quality is a dynamic condition that deals with products, services, people, processes, and environments that meet or exceed expectations. Different perspectives have been derived from the last decade to understand the term "quality". Every customer established some needs and these needs should be transformed into measurable characteristics. The final aim is to make the customer satisfied for what they paid for a service or a product. Some of the definitions are as follows (Kumar et al., 2016): • Quality is fitness for

the purpose • Quality is a degree of customer satisfaction • Quality is accuracy in meeting the specification or design • Quality is meeting the standards or norms • Quality is a degree of excellence.

2.2. Quality Control

According to Goetsch et al. (2014), quality control is an effective control system to coordinate quality maintenance efforts, and improve the quality during a production process, to satisfy consumer needs and desires. Mitra (2016) said that quality control is as an effective tool in reducing product defect.

2.3. PDCA

As stated by Moin et al. (2018), PDCA is a model for continuous improvement by planning, doing, checking, and acting. The PDCA cycle is generally used to test and implement changes to improve the performance of products, processes or a system in the future. As stated by Moen, R. and Norman, C. (2006), explanation of the stages in the PDCA cycle is Develop a plan (Plan), Carry out a plan (Do), Check or examine the results achieved (Check), and Make adjustments when needed (Action). There were 7 tools developed for PDCA, namely: 1. Check Sheet 2. Histogram 3. Pareto Diagram 4. Flow Chart 5. Scatter Diagram 6. Control Chart 7. Fish Bone Diagram. (Varsha et al., 2014).

2.4. Failure Mode and Effects Analysis (FMEA)

Liu et al. (2015) mentioned that FMEA is a structured procedure to identify and prevent as many failure modes as possible. They added that a failure mode is anything that is included in the defect, conditions outside the specified specifications, or changes in the product that cause disruption of the function of the product. The stages of applying FMEA are as follows 1. Descriptions and Objectives 2. Identifying Potential Failure Modes 3. Identifying Potential Failure Effects 4. Determining Severity Rating 5. Identifying Causes of Failure Potential 6. Determining Rating of Occurrence 7. Identification of Detection Level 8. Calculating Risk Priority Number (Dobryden et al., 2017).

3. Research Methodology

This research is an exploratory research that aims to determine the causal factors that cause problems. To solve this problem PDCA method is used by doing observation in the fish processing unit starting from the material reception until the final product processed. It does by improving the weakness of the process such as tightening the time of purchasing, adding fish containers, improve cooling room temperature, standardization of production process, providing dry ice inside the packaging to maintain the quality of loin. Then, evaluating the number of defect and compare it to the previous one. Last step is to do the standardization of the process and publish Standard Operation Procedures booklet as a guide to be followed during the production stage.

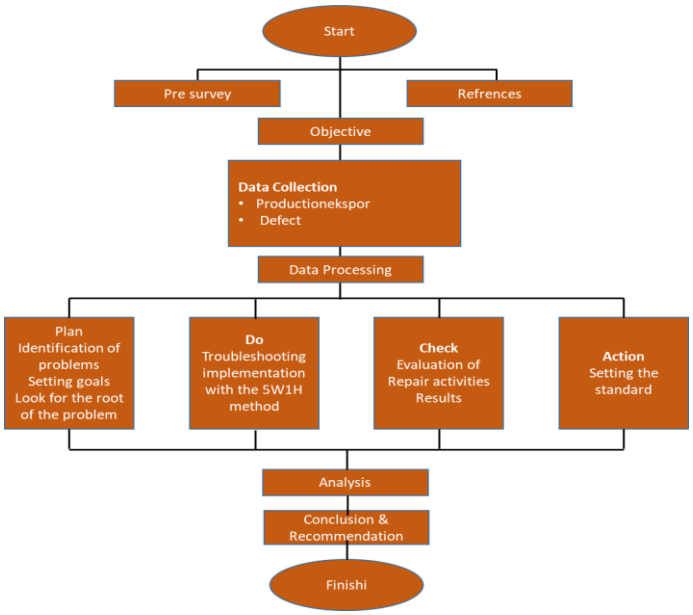


***Figure 1**. Research Process*

The primary data is obtained through direct interviews and direct field observations. While the secondary data to support this research is obtained from the documentation process data that exists in the company, including the amount of production and the number of product defects. The improvement process was supported by 7 quality control tools namely Check sheet, Histogram, Pareto chart, Control chart, Fishbone diagram, and Failure Mode and Effects Analysis (FMEA).

4. Results and Discussion

The following were the results of this study which were presented in the order of the PDCA approach.

4.1. Step 1: Plan

The first step in the improvement plan was to collect production data, the number of defects, and the type of defect. The information was recorded in the check sheet.

a. Defect product consists of two types, namely Color and Texture.

Table 1. *Defect Products*

No	Month	Defect	Amount (Kg)	Percentage (%)	Production (Kg)
1	Mar-18	Color	90.00	7.50%	1200
		Texture	60.00	5.00%	
2	Apr-18	Color	82.50	6.50%	1100
		Texture	52.80	4.80%	
3	May-18	Color	86.25	6.70%	1150
		Texture	51.75	4.50%	

b. Histogram was used to help determine the spread of the number of defects so that it could be found the types of product defects that occur most often.

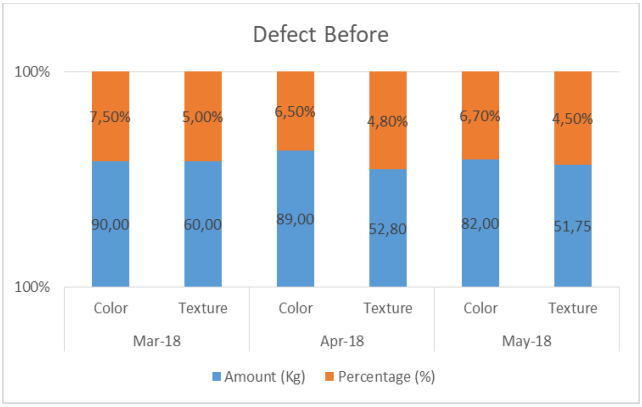


Figure 2. *The level of Product Defect*

c. Pareto diagram was used to describe what types of defects often occur frequently. The following is a Pareto diagrams for the period March-May 2018

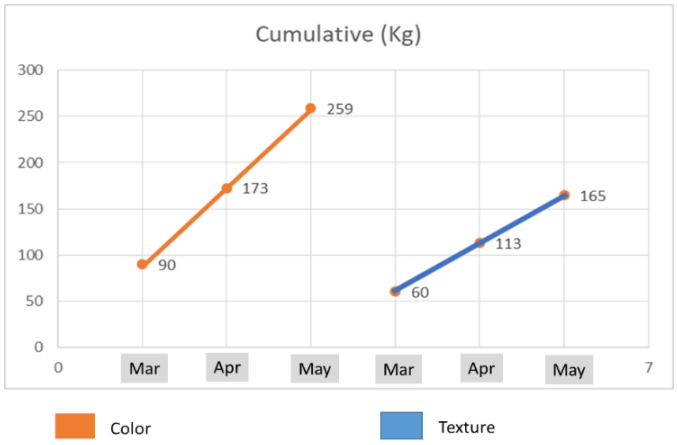
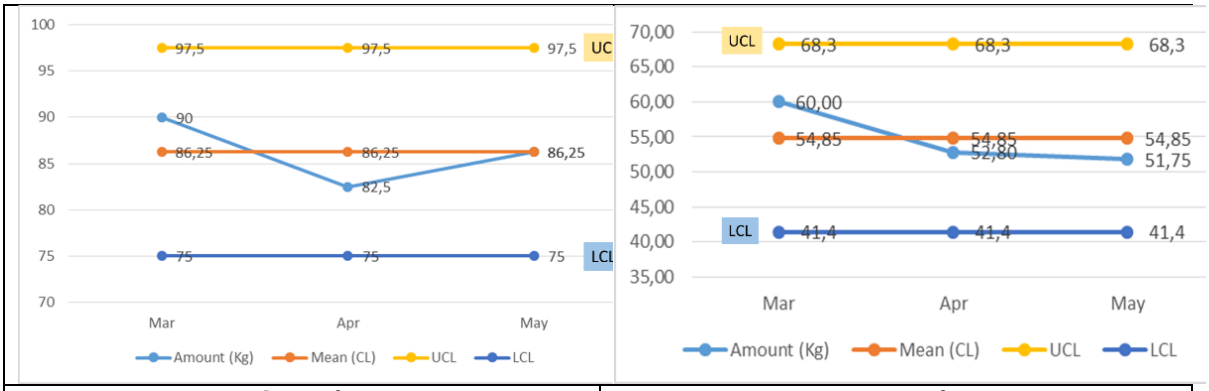


Figure 3*. Scatter of Product Defect*

d. Control Chart was used to see whether the quality control process that had been carried out had been controlled.



Color Defect	Texture Defect

Figure 4. *UCL, LCL and CL for Color and Texture Defects*

e. The causal diagram or commonly called fishbone diagram was useful to show the main factors as source of the causes of the defect during production activities.

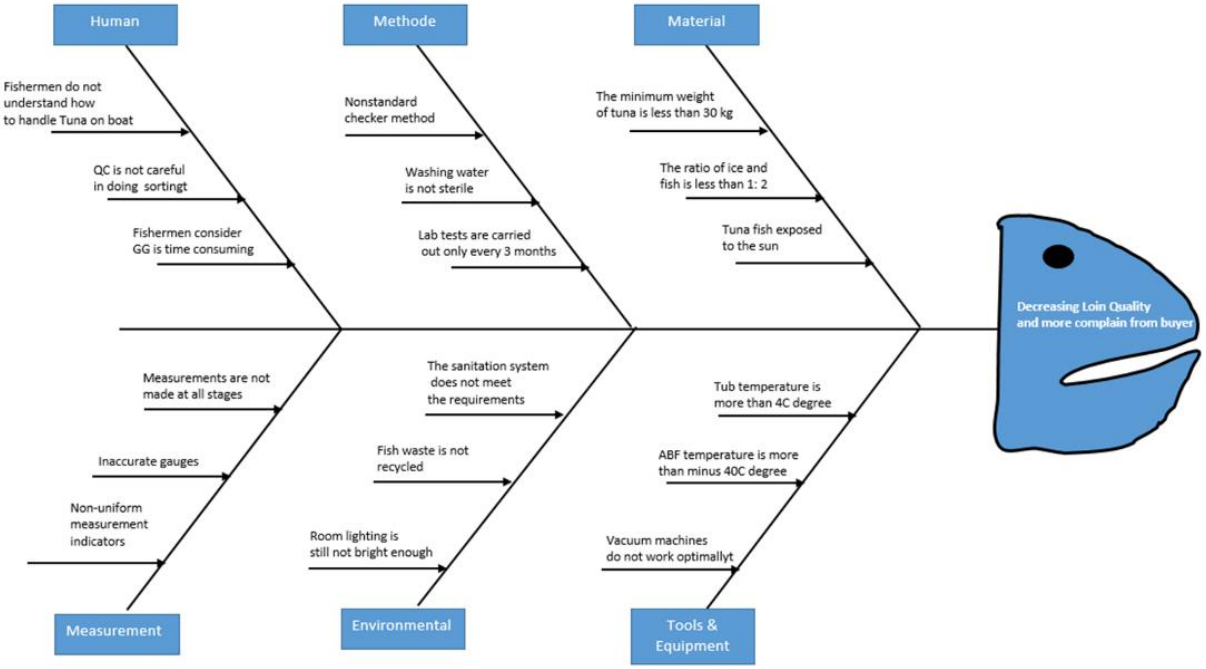


Figure 5. *Fishbone*

f. Failure Mode and Effects Analysis (FMEA) was adopted from Ford Motor Company to describe which type of defect that has more significant impact compare to the others.

Table 2. *FMEA*

No	Defect Mode	Defect Effect	Cause of Defect	Detection Process	S	O	D	RPN
1	Color	Plain Color	exposed to sunlight	Random sampling	4	5	4	80
2	Texture	Bad Texture	Broken Cold Chain	Random sampling	4	6	5	120

Note: S: Severity 1-10; O: Occurrence 1-10; D: Detection 1-10; RPN: Risk Priority Number (OxD)

g. Corrective Action Plan. Corrective action was basically the plan to overcome two problems regarding color and texture. To solve color problem there were 5 variables to be corrected.

Table 3. *Color Correction Plan*

No	Causes	*What*	*Why*	*How*	*Where*	*Who*
	Description	**Ideas**	**Measures of Success**	**How to apply**	**Location**	**PIC**
1	Processing room is not bright enough	Adding light intensity	Space becomes bright	Additional lights in the checked room	Special checker room	Engineering Section Employee
2	Fish inspection is not strict	Tightening the quality of fish during the inspection on board	The whole tuna that is purchased really has sashimi grade quality	Socialization of tuna fishers	On the ship	Checker clerk
2	The temperature in process room	Repair the cooling engine as soon as possible with a maximum temperature of 20oC	The maximum process room temperature is 20oC	Special mechanical cooling machine call (AC)	Production room	Mechanical officer
3	Change of process flow	Establishing a fixed standard for the flow of the production process for fresh loin tuna	Every production process must have a fixed flow	Re-adjustment of the right production space	Production room	Production staff and employees
4.	Packaging only uses ice jelly	Providing dry ice for each box of fresh tuna loin	Decreasing complaints from customers	Purchasing dry ice every time there is a production process	Packing room	Production employees

While to make correction for Texture problems, there were 2 variables need to be revised.

Table 4. *Texture Improvement Plan*

No	Causes	*What*	*Why*	*How*	*Where*	*Who*
1	Rough handling	The awareness of employees is the importance of good and smooth handling of fish that are still intact	Tuna loin does not become soft and broken	Dissemination of whole fish reception officers.	Raw material reception room	Production officer
2	Manual transfer of fish	Adding tools to facilitate the process of moving fish	Tuna loin does not become soft and breaks when loin	Provision of aids for the removal of fish	Production and acceptance of raw materials	Production officer

4.2. Step 2: Do

Improvements was made to reduce defects due to the decrease in color quality with the 5W + 1H

a. Color Correction. There were 5 stages used to solve 5 problems that cause the drop in color quality**.**

Table 5. *Color Correction No. 1*

	5W+1H	**Descriptions**	
The checker room is not bright enough	*What*	Proposed improvements: Adding light intensity	
	Why	Checker work that relies on visuals becomes less accurate	
	Who	Checker Officer	
	Where	Production room/checker	
	How	The improvement step done here is by comparing the intensity of the light before and after repaired	
		Before repaired	After repaired
		The plug is not optimal in checking the quality of the fish	*Checkers are more accurate in checking ship quality*

This was the problem regarding the light in the checker room. It should be added more light to increase the brightness of the room.

Table 6. *Color correction Cause No. 2*

Problem	**5W+1H**	**Descriptions**	
Fish inspection is not strict	*What*	Proposed improvements: Tightening the quality of fish during the inspection on board	
	Why	The whole tuna that is purchased really has sashimi grade quality	
	Who	Checker Officer	
	Where	Above the ship/place of a demolition of tuna	
	How	The improvement step taken here is by comparing the quality of tuna fish that is in accordance with the wishes of consumers and which is not appropriate.	
		Before repaired	After repaired
		Checkers are less strict in checking every purchase of fish	*The plug is tighter when checking fish while on board*

In this inspection activity, make sure the checker did his job appropriately to reject all low quality material during the inspection process.

Table 7. *Color correction Cause No. 3*

Problem	**5W+1H**	**Descriptions**	
Hot temperature in the process room	*What*	Proposed improvements: Repair the cooling engine as soon as possible with a maximum temperature of 20oC	
	Why	The maximum process space temperature must be 20oC	
	Who	Refrigerator mechanic	
	Where	Production process room	
	How	The corrective steps taken here are a special mechanical call for a cooling machine (AC)	
		Before repaired	After repaired
		Temperature space between 27oC - 30oC	Temperature process space is a maximum of 20oC

Table 8. *Color correction Cause No. 4*

Problem	**5W+1H**	**Descriptions**	
Change of process flow	*What*	Proposed improvements: Establish a fixed standard for the flow of fresh loin tuna production process	
	Why	Every production process must have a fixed flow	
	Who	Production staff and employees	
	Where	Production process room	
	How	Re-adjustment of the right production space	
		Before repaired	After repaired
		The production process changes and the process flow is longer.	The process flow is shorter and shorter.

During the processing time, the cold chain had to be there, including the temperature in processing room.

Table 9. *Color correction Cause No. 5*

Problem	**5W+1H**	**Descriptions**	
Packaging only uses ice jelly	*What*	Proposed improvements: Giving dry ice to each box of fresh tuna loin	
	Why	Decreasing complaints from customers	
	Who	Production employees	
	Where	Packing room	
	How	Purchasing dry ice every time there is a production process and giving to each tuna loin box	
		Before repaired	After repaired
		The packaging process only uses ice jelly	The use of sugar ice and ice jelly as cooling media in Styrofoam

Jelly ice was always the problem since the stock of jelly ice was limited. Need to buy sufficient amount of jelly ice so every boxes shipped has enough jelly ice on it.

b. Texture Correction

There were two major problems need to be solved regarding the low quality of the texture.

Table 10. *Texture Correction No.1*

Problem	**5W+1H**	**Descriptions**	
Rough Handling	*What*	Proposed improvements: Socialization of employees is important for the good and smooth handling of fish that are still intact	
	Why	Tuna loin does not become soft and broken	
	Who	Employees produce reception	
	Where	Raw material reception room	
	When	June 1, 2018	
	How	Socialization of whole fish reception officers	
		Before repaired	After repaired
		Employees move whole fish roughly	Employees are more careful in handling whole fish

The employees need to treat the tuna carefully as a baby, to avoid a texture problem.

Table 11. *Texture Correction No.2*

Problem	**5W+1H**	**Descriptions**	
Manual transfer of fish	*What*	Proposed improvements: Add tools to facilitate the process of displace fish	
	Why	Tuna loin does not become soft and breaks	
	Who	Production employees	
	Where	Raw material reception room	
	When	June 2018	
	How	Addition of tools for the process of displacing fish	
		Before repaired	After repaired
		Employees displace whole fish roughly	Employees are easy and light in moving fish

It is suggested to use supporting equipment to mobilize fish from one place to another to make sure the tuna always in a better condition

4.3. Step 3: Check

a. Check Sheet. The first step at this stage was to collect production and defect data in the period of June - August 2018. The following table shows the information about defect product after the improvement.

Table 12. *Defect After Improvement*

No	**Month**	**Defect**	**Amount (Kg)**	**Percentage (%)**	**Production (Kg)**
1	Jun-18	Color	54.00	7.50%	1350
		Texture	40.50	5.00%	
2	Jul-18	Color	51.00	6.50%	1275
		Texture	31.88	4.80%	
3	Aug-18	Color	60.84	6.70%	1352
		Texture	37.18	4.50%	

b. Below was histogram of the defect after improvement.

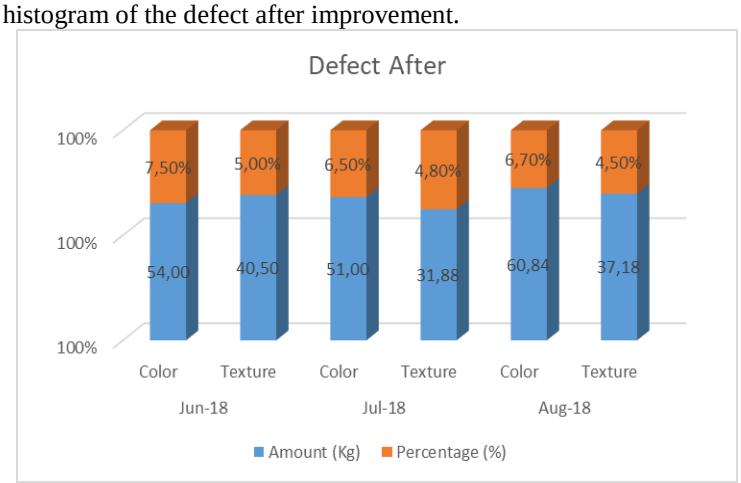


Figure 6. *The Defect after the Improvement*

c. Pareto Diagram

After the data of June-August 2018 period was collected, the next step was to make a Pareto diagram to make it easier to see for each type of defect.

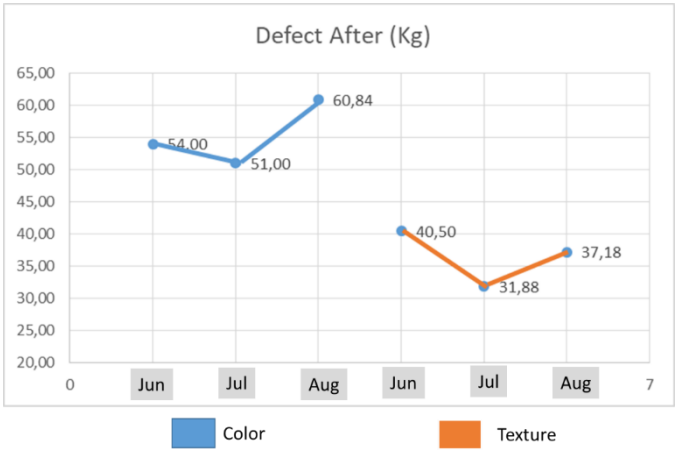


Figure 7. *Pareto Diagram after the Improvement*

d. Control Chart.

After making a Pareto diagram, the next step was to do an analysis using a control chart to find out whether the corrective actions that had been carried out were successful or not

Table 12. *Color After the Improvement*

No	Month	Production (Kg)	Amount (Kg)	Mean (CL)	Proportion	Mean (CL)	SD	UCL	LCL
1	Jun	1350	54	55.28	0.040	0.042	0.003	0.050	0.033
2	Jul	1275	51	86.25	0.040	0.042	0.003	0.050	0.033
3	Aug	1352	61	86.25	0.045	0.042	0.003	0.050	0.033

Table 13. *Texture After the Improvement*

No	Month	Production (Kg)	Amount (Kg)	Mean (CL)	Proportion	Mean (CL)	SD	UCL	LCL
1	Jun	1350	41	36.52	0.030	0.0275	0.0025	0.035	0.020
2	Jul	1275	32	54.85	0.025	0.0275	0.0025	0.035	0.020
3	Aug	1352	37	54.85	0.028	0.0275	0.0025	0.035	0.020

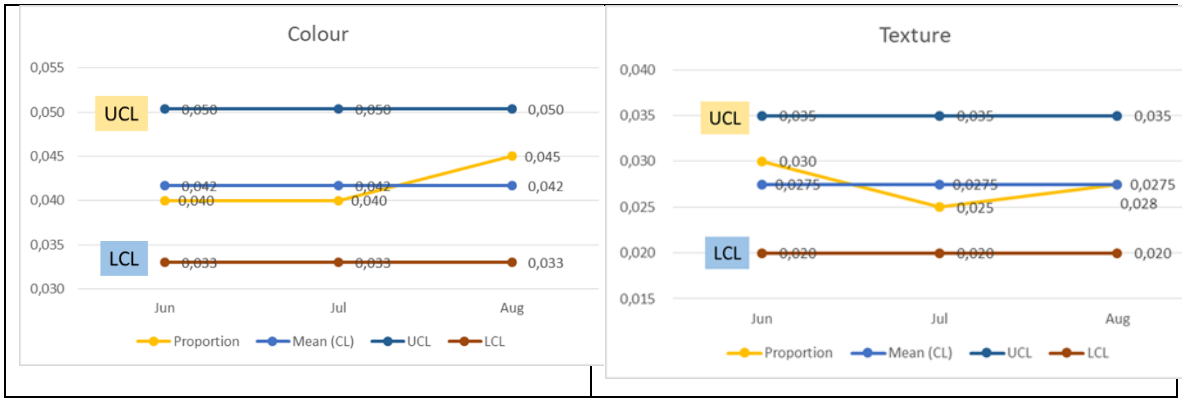


Figure 8. *UCL, CL and LCL after the Improvement*

e. The result. The following is the data before and after the Improvement.

Table 14. Comparison Before and After

Before		After		Difference		Difference (%)	
Color	Texture	Color	Texture	Color	Texture	Color	Texture
0.075	0.050	0.040	0.030	0.035	0.020	47%	40%
0.081	0.048	0.040	0.025	0.041	0.023	51%	48%
0.071	0.045	0.045	0.028	0.026	0.018	37%	39%
Average						45%	42%

By seeing the information in the table we could recognize that there was a significant impact in decreasing both the defect of color and texture by 45% and 42% respectively.

4.4. Step 4: Action

After several corrective actions had been taken in the production activities in June 2018 and re-checking the results of repairs during the June-August 2018 period, it could be seen that the quality problems that occur had been minimized. The defect rate decreased by 45% and 42% respectively for Colour and Texture. The next step was to maintain the results that had been achieved to prevent the recurrence of the same problem happen again as well as for the purposes of quality control in the future. This is what we call a standardization process or Action in PDCA approach. This standardization should be written in operational procedures (SOPs) and posted on the walls of the production room. The standards that had been set was not a fixed or final. It can be modify whenever needed.

5. Conclusion and Limitation of the Study.

From the results and findings of this study, we understand that there were a significant decrease of both color and texture defect by 45% and 42%. Thus Tuna Loin processing companies, especially small-scale ones, can implement the same approach in solving problems related to low quality of Tuna to improve the quality to meet buyer expectation. By providing a good quality of Tuna loin, hopefully the complaint from buyer also decrease significantly because we have enough good quality product to be shipped to them.

Because this research is very limited in the scope, the future research related to quality improvement can be expanded by representing Tuna processing companies on a larger scale, so that the results can be generalized to give some contribute to the knowledge related to the product quality.

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