Defect Reduction in Crispy Coconut Rolls Production Process

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***Abstract*—The objective of this research is to reduce the defect in the production process of crispy coconut rolls. By using the quality control tool (QC Tool) to find the cause and improve the quality of the production process. This research has used the Check Sheet to find the point outside the control line by using the waste control chart (P-Chart) and the Pareto diagram to distinguish the importance of sequential problems with Pareto's 80: 20 laws for selecting the most defects in the out of shape. Will focus on this one type of defect and apply this waste reduction in crispy coconut rolls. The problem was analyzed with a fishbone diagram to set up measures to solve the problem.**

The improvement result was able to reduce waste caused by the crispy coconut rolls production process from the previous loss of 5,028 kg accounting for 8.6%, decreased to 2,949 kg accounting for 3.4%, a decrease from June to November 2021 can reduce waste due to amorphous piece of works by 2,079 kg, representing a percentage of waste that can be reduced by 58.65%, representing an annual loss of 415,734 baht per year.

***Index Terms*—Waste, 7 QC Tools, Efficiency**

I. Introduction

A. Statement of The Problems

In Thailand, the food processing industry is now regarded as a significant manufacturing sector. Food production is expected to expand by 4.5% in 2021, while exports are expected to increase by 7.1%, totaling 1.05 trillion baht (National Food Institute). Due to higher competition and increased production costs. This forces manufacturers to develop production processes in order to compete on quality control and cost reduction.

This is a food processing industry case study. There is a problem with quality control. The majority of the waste in the process and all waste data from the crispy coconut rolls machinery was collected for three months from June to August because of the forming process of crispy coconut rolls. From Table I the data show total production volume of the production line was found to be 412,195 kg.

During the forming process of crispy coconut rolls. The machine that produced the most waste was the third machine, which produced a total of 8,834 kg of waste.

The study shows that the crispy coconut roll forming process generates the majority of the waste in the production process, so the researcher believes that reducing waste in the forming process will increase profits and lower costs. The amount of waste generated in each machine during the crispy coconut rolls production process from June to August 2021 is shown in Table I.

TABLE I
The Amount of Waste Generated in Each Machine

Machine	Total Defect (kg)	Total Finished Goods (kg)	Total (kg)	% Defect
M/C1	6,547	76,576	83,123	22
M/C2	4,290	79,758	84,048	14
M/C3	8,834	63,448	72,282	30
M/C4	4,453	84,496	88,949	15
M/C5	5,640	78,154	83,794	19
Total	**29,764**	**382,432**	**412,195**	**100**

Using statistical quality control concepts to determine the problem's core cause and systematically eradicate the problem's primary cause quality control tools have been utilized in several studies to reduce the amount of waste generated throughout the manufacturing process as well as increase efficiency. As a result of the research study, reducing waste from the crispy coconut rolls manufacturing process can be done by reducing out-of-form workpieces can assist in lowering production costs the original loss of 5,028 kg of product value was reduced to 2,949 kg as a result of this approach. If the reduced cost is 103,934 baht per three months, the marketing value is 415,734 baht per year.

B. Scope of Study

• This research focuses on the study data of a case study company.

• This research uses a chart to control the proportion of defects in the study of quality data.

• Only investigate the No. 3 crispy coconut rolls-making machine. Timeframe for research: June to November 2021.

C. Objectives

This research aims to study the quality of production and reduce waste in the crispy coconut rolls manufacturing process after applying knowledge management processes in a case study in the food industry.

II. Literature Review

A. Quality Control

Quality control is first known in the industrial business. It refers to management in order to control raw materials and production to prevent mistakes and damage to final products. After that, quality control is adopted with statistical data, and statistical principles and methods are applied to quality control. Therefore, quality control is insensitive in many industries [1].

William Edwards Deming was the first one to introduce concepts of quality controls to Japan and apply Statistics Quality Control (SQC). SQC mean to use theories and statistical method in every step of production in order to produce and save cost at the same time. Deming proposed deming's 14 points and insisted that his quality control theory can be applied well the both in service and industrial sectors.

B. Theories of Control Chart

Control Chart is a tool developed for production process control. In the Production process. There is variation caused by 4 main factors:

• Material
• Machinery
• Method of work
• Man-Made error

To find cause-and-effect Analysis Tools: A fishbone diagram is a cause-and-effect discovery tool that helps visualization for categorizing the potential causes of a problem.

Element of Control Chart

One of the most effective tools that are widely used in the control phase is the control chart. This tool is effective in monitoring the improvement levels and process there are many types of such charts and all depend on the overall data that have been collected or have to be collected. When applying the statistical approach, the control chart can be different for binominal distribution and poisson distribution for binominal distribution, the collected data is based on two possible outcomes: the existence of the defect and the non-existence of the defect. However, the poison distribution has multiple outcomes, as there is one margin where the defect in the production units is stated in addition, the poisson distribution-based control chart also includes errors [2].

The control chart consists of three main lines as shown in Fig. 1 to Fig. 4.

• Central Line (CL)
• Upper Control Line (UCL)
• Lower Control Line (LCL)
• Control Chart (CC)

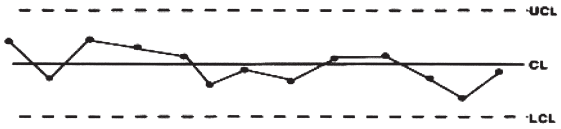

Fig. 1. Element of control chart (normal)

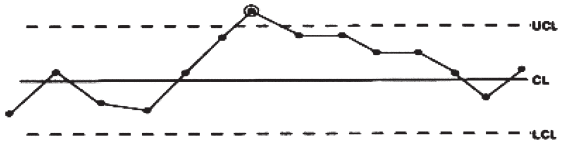

Fig. 2. Element of control chart (special cause)

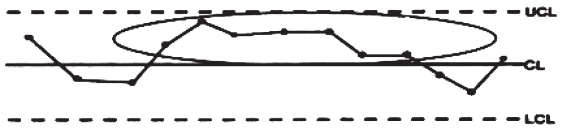

Fig. 3. Element of control chart (trend)

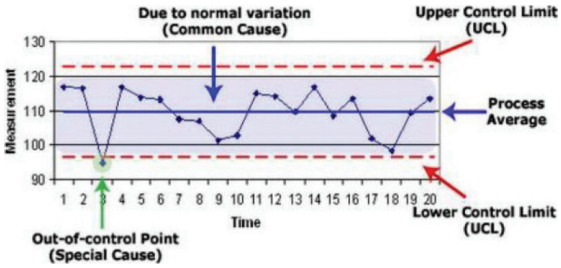

Fig. 4. Control chart

To understand product waste management, it has been suggested that waste in manufacturing should help find the root cause of the problem, waste reduction and production control Quality Control Tools (QC Tools) are used. Data was collected using the check sheet, which included surveying the waste condition and obtaining data from the inspection department on the amount of waste generated during the manufacturing process, as well as stating the problem [3]. To prioritize, use a Pareto chart and the 80:20 rule to select the most wasteful product, and then use a fish-bone diagram to analyze the problem and devise measures. Solve problems using brainstorming and compare all data before and after improvement [4]. Once the problem's main cause has been recognized, it's time to plan and design a solution, using the 5W 1H concept as a guideline. There must be performance standards in place to avoid the recurrence of problems [5].

III. Research Methodology

The steps that will be taken for research completion are as follows

- Study the relevant theories and data collection tools
- Define the problem and research data process
- Designing the experiment to find parameters and Testing
- The data analyzing
- Improve and decision-process
- Report the result in Results and Discussion [6]

A. Process Analysis

To investigate and analyze the problem, the process analysis is first conducted to identify the problem in the manufacturing process of crispy coconut rolls.

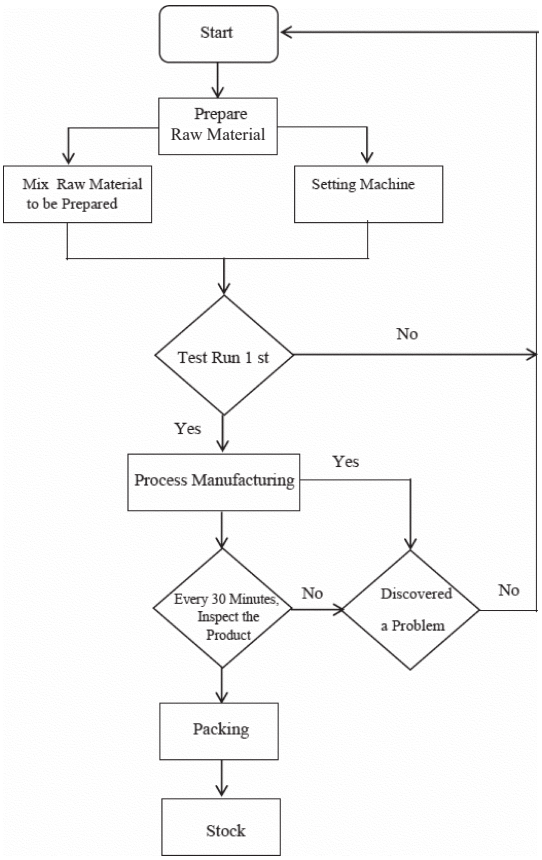

Fig. 5. Process flow of crispy coconut rolls

From the illustration shown in Fig. 5, The first step in the process is to prepare the ingredients for and production then mix the raw materials according to the production formula to make them vicious and meet the starch water requirements. For in-process operation start the machine and setting system then test run the product. The retort process has to be closely inspected by inspectors every 30 minutes to ensure that defective products do not pass to the packing process and customer. The defect after the retort process can be classified into four types of defects.

The researcher has observed operations collecting data on the types of waste in the production process. From the illustration, as shown in Fig. 6 check sheet tool was only used to record the data, and the data from the check sheet was used for more analysis for the next step.

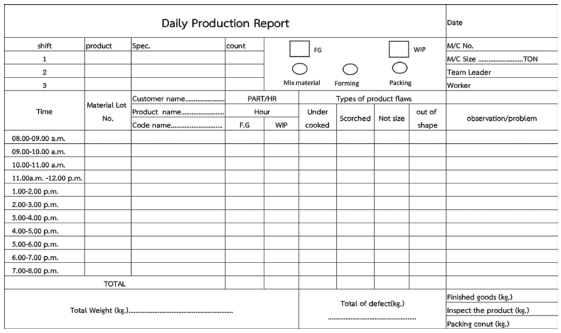

Fig. 6. Check sheet example

The next step summarizes the amount of waste detected and records it on the check sheet. From June to August 2021, problems were detected and the total number of detections was indicated.

TABLE II
THE TOTAL NUMBER OF TYPE OF DEFECT

Type waste	**Number of Defects (kg)**	**% Percent Defect (kg)**	**%Total Percent Defect (kg)**
Out of Shape	5,028	57	57
Not the Right Size	2,178	25	82
Undercooked	823	9	91
Scorched.	805	9	100
Total	**8,834**	**100**	**-**

From Table II, the data show the total number of each type of defect.

Use the waste data from crispy coconut roll production that does not meet all of the standards to classify the waste. The Pareto chart shows Fig. 7 represents it type of defects that are prioritized and need to be focused total piece number of defective products.

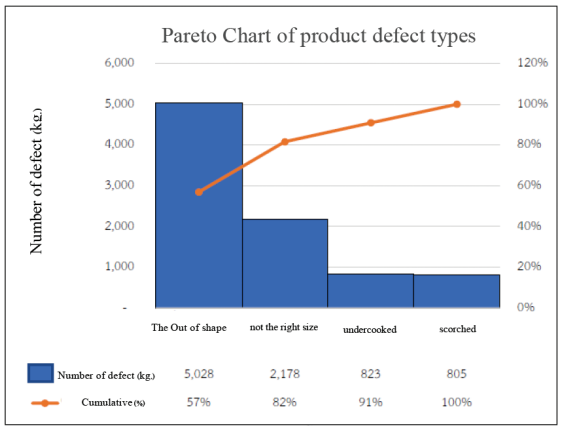

Fig. 7. The number of each defective type of crispy coconut rolls

The pareto chart of crispy coconut rolls shown in Fig. 7 represents four types of defects. The out-of-shape contributed 57%, not the right size contributed 25% undercooked contributed 9%, and scorched contributed 10%, respectively. Fig. 8 shows a picture of the defect type.

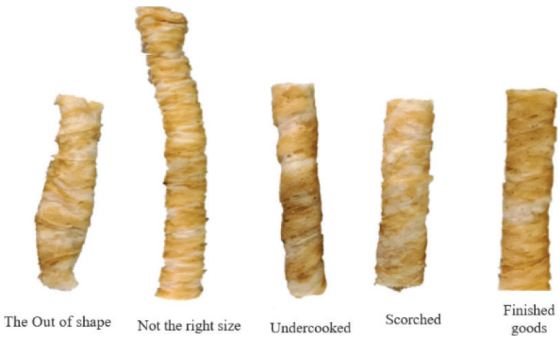

Fig. 8. Shows a picture of the defect type

Pareto charts show the ordered frequency counts of values for the different levels of a categorical or nominal variable. The charts are based on the "80/20" rule. This rule says that about 80% of the problems are the result of 20% of causes.

The Pareto chart represents the total waste of one major type of defect; the shape contributed 57% of total waste. In conclusion, this study research will focus on this one type of defect and the company can apply this waste reduction in crispy coconut rolls study to another defect type in the future.

B. Cause and Effect Analysis Tools

The researcher analyzes and determines the causes of the problems related to defect types.

The first step is to conduct an analysis using a cause and effect diagram. That is a cause and effect discovery tool that helps visualization for categorizing the potential causes of a problem. Typically cause and effect diagram combines the practice of the brainstorming process and encourages broad thinking, keeping users from limited thinking patterns that can lead to getting stuck, the process of asking why something happened repeatedly at each stage helps drill down to one or more root causes.

From the cause and effect diagram, it was found that the cause of the waste was due to the deformed work piece, which was the waste caused by people, machines, raw materials, and methods. Which proceeds to find the cause and the solution as follows:

Manpower

• Be inexperienced and unaware of how to operate a machine.

• Lack of Trained Experts shown in Fig. 9.

Fig. 9. The operational or functional labor of people engaged.

Machine the more misuse or lack of maintenance a machine shown in Fig. 10.

•The machine is to heat.

Fig. 10. Equipment used for production.

Material is a production process and contributes to service delivery processes.

• Blade wear

• Change the formula of the raw materials used in the manufacturing process.

• The sensor is not working.

• The roll spool is worn shown in Fig. 11.

Method

• The device settings aren't standardized.

• Keeping the work environment clean shown in Fig. 12.

• Work checks that aren't appropriate

Fig. 11. The technical repair roll is worn out.

Fig. 12. Keeping the work environment clean

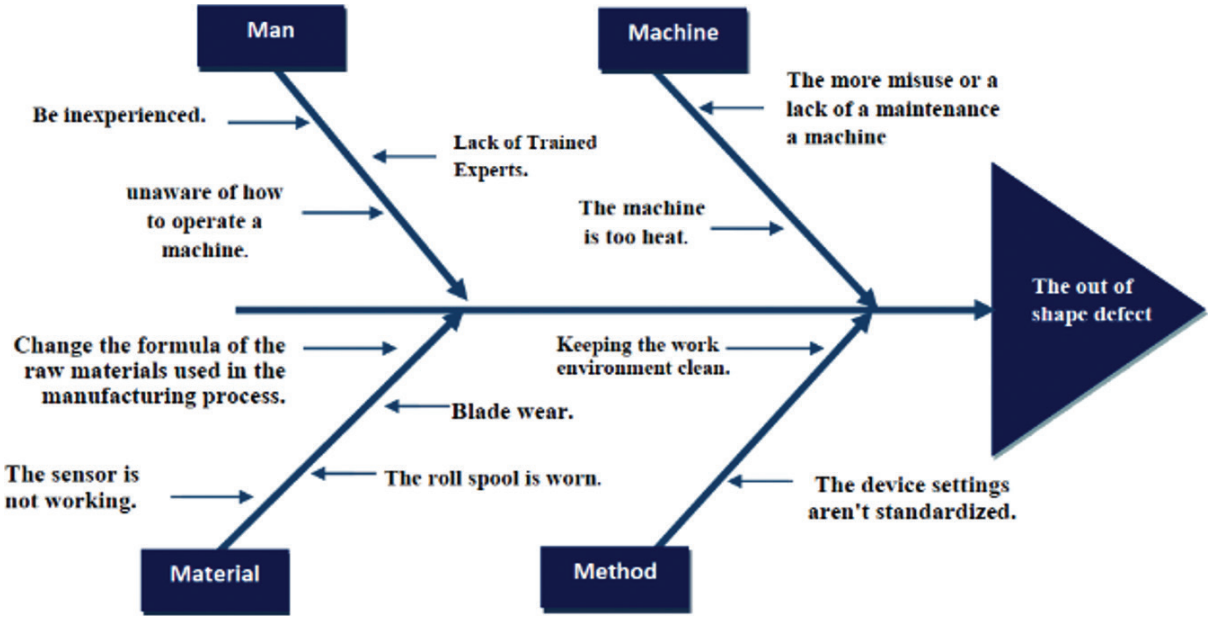

Fig. 13. Cause and effect diagram of the out of shape defect

When many causes are identified, the researcher has to analyze the importance of the detail of each cause can be controlled by controlling a plan or recommended action as identified in Table III.

This article uses a cause-and-effect diagram [7] shown in Fig. 13. It is a tool for brainstorming to find the cause of the forming process of crispy coconut rolls to find a solution to the problem.

TABLE III
PROPOSE A SOLUTION TO THE PROBLEM AND ACTION CAUSES OF THE DEFECT

Causes	Recommended Action
Be inexperienced and unaware	Staff training and qualification program
Lack of Trained Experts.	Staff training and qualification program
The more misuse or a lack of maintenance of a machine	Staff training and problem-solving
The machine is too heat.	Preventive maintenance
Blade wear	Preventive maintenance
Change the formula of the raw materials	Production planning on an Ongoing Basis
The sensor is not working.	Check the performance and condition of the machine
The roll spool is worn.	Check the performance and condition of the machine
The device settings aren’t standardized.	Check the performance and condition of the machine
Keeping the work environment clean.	Assign cleaning duties
Work checks that aren’t appropriate.	Staff training and problem-solving

Improvement guidelines, meetings with relevant production process working groups to put them into practice, improvement trials with the production process in mind, and continuous monitoring of operations are all part of the process.

IV. Results

Apply knowledge management process. When corrective action is taken in the production process according to predetermined remedial guidelines, the researcher has adopted a solution to improve all factors and all causes of problems together to make improvements in an integrated manner. The pre-improvement waste data from June to August 2021 was compared to the post-improvement waste generation data from September to November 2021, which accounted for the proportion of the waste generated. The waste was generated by all production processes during that time.

The waste in June 2021 will be out of shape. Out of shape from the crispy coconut roll production process amounted to 1,849 kg or 9.37 percent of the total weight produced (19,730 kg).

The data was used to create a control chart for the manufacturing process shown in Fig. 14. The results of the crispy coconut roll production process, which was quality checked. A total of 5 points outside the upper control line were discovered to be wasteful on June 5th, 8th, 9th, 14th, and 24th, 2021.

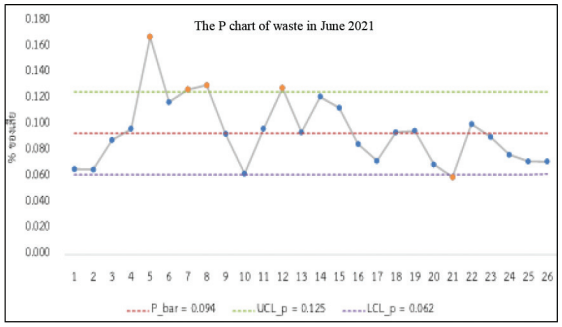

Fig. 14. The P-Chart shows points outside the upper control line in June 2021 before the improvement.

The waste in July 2021 will be out of shape. Out of shape from the crispy coconut roll production process amounted to 1,617 kg or 8.56 percent of the total weight produced (18,894 kg).

The data was used to create a control chart for the manufacturing process shown in Fig. 15. The results of the crispy coconut roll production process, which was quality checked. A total of 3 points outside the upper control line were discovered to be wasteful on July 2nd, 4th, 9th, and 21st, 2021.

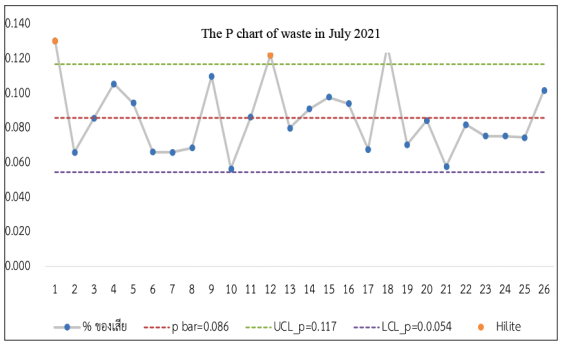

Fig. 15. The P-Chart shows points outside the upper control line in July 2021 before the improvement.

The waste in August 2021 will be out of shape. Out of shape from the crispy coconut roll production process amounted to 1,562 kg or 7.79 % of the total weight produced (20,051 kg).

The data was used to create a control chart for the manufacturing process shown in Fig. 16. The results of the crispy coconut roll production process, which was quality checked. A total of 4 points outside the upper control line were discovered to be wasteful on August 7th, 9th, 19th, and 24th, 2021.

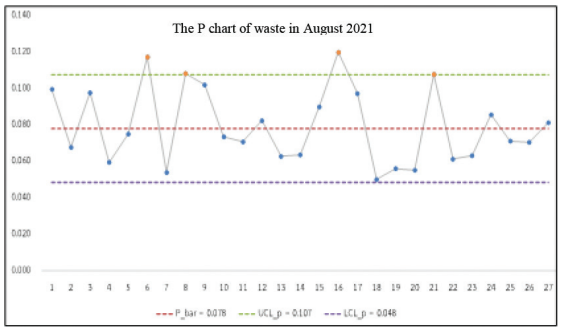

Fig. 16. The P-Chart shows points outside the upper control line in August 2021 before the improvement.

TABLE IV.
THE AMOUNT OF WASTE THE OUT OF SHAPE FROM JUNE-AUGUST 2021

Month 2021	Total Finished goods (kg)	Total Defect (kg)	Percent Defect (Average)
June	19,730	1,849	9.37
July	18,894	1,617	8.56
August	20,051	1,562	7.79
Total	58,675	5,028	8.57

Table IV, the amount of waste from the outshape of June-August 2021. Data on the occurrence of out-of-shape defects from June to August 2021. Prior to the improvement, wastes resulting from the

manufacturing process were discovered in chronological order. Obviously, 5,028 kg of waste were produced out of total production of 58,675 kg, resulting in an 8.7% waste percentage.

Data on post improvement waste in the manufacturing industry from September to November 2021, Fig. 17 to Fig. 19 depicts the data. The P chart shows non-points outside the control line.

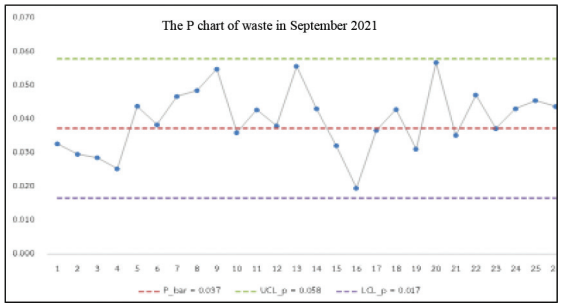

Fig. 17. The P chart shows non-points outside the control line in September 2021 after the improvement.

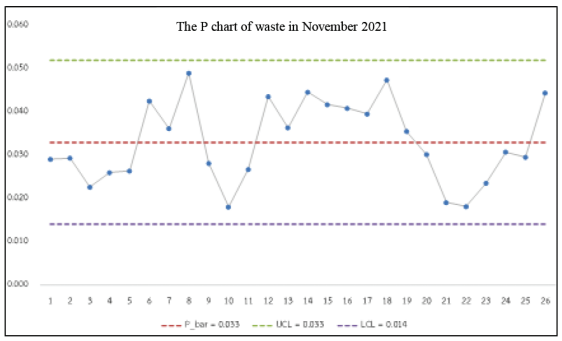

Fig. 18. The P chart shows non-points outside the control line in October 2021 after the improvement.

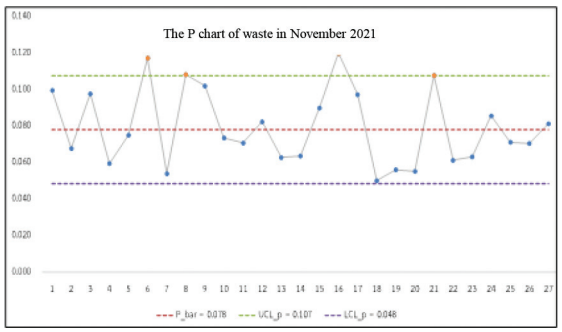

Fig. 19. The P chart shows non-points outside the control line in November 2021 after the improvement.

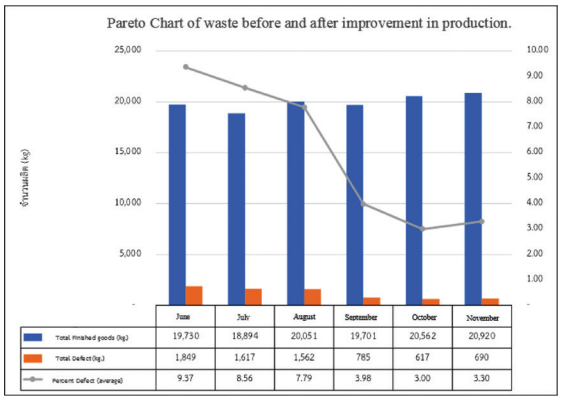

Fig. 20. Graph comparing the proportion of waste before and after improvement in production.

TABLE V.
THE AMOUNT OF WASTE THE OUT OF SHAPE OF SEPTEMBRR - OCTOBRT 2021

Month 2021	Total Finished goods (kg)	Total Defect (kg)	Percent Defect (Average)
September	19,701	785	3.98
October	20,562	617	3.00
November	20,920	690	3.30
Total	**61,183**	**2092**	**3.42**

From September to November 2021, shows a summary of defects caused by the product being out of shape. Following the improvements, it was discovered that there were wastes from the manufacturing process in order. A total finished goods of 2,092 kg with a defect waste percentage of 3.4%.

Summary of the findings Following the revision and improvement plan, it was discovered that the piece of work was out of shape due to the crispy coconut roll manufacturing process. As shown in Fig. 20, the data was sorted in order from June to November 2021.

V. DISCUSSION

The Scope of the research study is only crispy coconut rolls work-piece type of defect is out of shape. Therefore, the factors for production might be different from this analysis.

Monitoring using the control chart to control the process, a control chart is developed to monitor the process's performance. Because the study is related to the defective rate of one major defect type, the P-chart is the appropriate control chart to monitor the proportion of defects that occurred in the production line.

VI. Conclusion

This experimental study collects data on pretest-posttest improvement with the goal of controlling the quality of crispy coconut rolls in the food processing industry by comparing the defect amount to the product quality of manufacturing before and after implementing quality control through the control chart.

Table VI includes the following items: a comparison of defective products between before and after using a control chart in September-October 2021.

TABLE VI
Comparison of Defective Product Types That are Out of Shape Between Before and After

	Month 2021	Total Defect (kg)	% Defect (Average)
Before	June	19,730	9.37
	July	18,894	8.56
	August	20,051	7.79
After	September	19,701	3.98
	October	20,562	3.00
	November	20,920	3.30

The information was compared. In September-November 2021, defects saw a significant reduction in waste, which was reduced by 2,079 kg on average as a percentage from 9.37 percent to 3.0 percent, a decrease of 6.37 percent.

Based on the amount of waste that was reduced from 5,028 kg to 2,949 kg, a total of 2,079 kg can be saved. It can be reduced by 58.65% in terms of waste percentage. When the reduced waste is compared to the lost product marketing opportunity in June-November 2021, the loss of product marketing opportunity is determined.

When the finished product is ready, customers will be able to buy it in kilograms at a price of 50 baht. As a result of this process, the product's value loss will be reduced from the original loss of 5,028 kg The weight has been reduced to 2,949 kg If the annual loss is 415,734 baht, the marketing value in three months is 103,934 baht.

VII. Suggestion

1) Study the use and application of the control chart in the quality control process in other food product lines.

2) Study the control chart in a group of defect types that are out of shape so that the data received can be compared with the amount of waste before and after improvement.

Quality control tools can be applied to other production processes as a result of the study of defect reduction in the crispy coconut rolls production process using quality control tools. to lessen the amount of waste produced.

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