การปรับปรุงผลิตภาพของโรงงานปลาทูน่ากระป๋อง

Productivity Improvement of Canned Tuna Factory

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บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อการนำเสนอแนวทางการปรับปรุงผลิตภาพสายการนึ่งปลา ในกระบวนการผลิตของโรงงานปลาทูน่ากระป๋อง โดยการศึกษา และวิเคราะห์ปัญหาที่เกิดขึ้นกับทางสายการนึ่งปลาและนำเสนอแนวทางในการแก้ไข เพื่อเพิ่มประสิทธิภาพในสายการนึ่งปลาทูน่ากระป๋องของโรงงานในกรณีศึกษา จากการศึกษาวิจัยพบว่าเกิดคอขวดที่บริเวณขั้นตอนการนึ่งปลา ซึ่งได้ทำการแก้ไขโดยการปรับเปลี่ยนขนาดของวัตถุดิบโดยไม่มีผลกระทบต่อค่าปริมาณผลผลิตของวัตถุดิบก่อนเข้าสู่กระบวนการนึ่ง ผลการวิจัยพบว่าหลังจากการปรับปรุงแล้วสามารถนึ่งจากวัตถุดิบปลาขนาด 1.4-1.8 กก. เพิ่มขึ้น 67.74 ตัน/เดือน คิดเป็น 20% วัตถุดิบปลาขนาด 3.0-3.4 กก. เพิ่มขึ้น 103.22 ตัน/ เดือน คิดเป็น 33.33 % และวัตถุดิบปลาขนาด 5.0-6.0 กก. เพิ่มขึ้น 72.07 ตัน/เดือน คิดเป็น 25 % ตามลำดับ ซึ่งปลาทุกขนาดสามารถผลิตได้เกินกว่า 350 ตัน/ เดือน จากการปรับปรุงวัตถุดิบก่อนกระบวนการนึ่งทำให้สามารถแยกขายวัตถุดิบหัวปลาแบบสดทำให้ปลาทุกขนาดมีมูลค่าเพิ่มขึ้น 8.33%

Abstract

The research aimed to propose a guideline to improve productivity of fish streaming line in the production process of canned tuna factory, by studying and analyzing a problem with the fish streaming line and proposing a guideline to solve the problems and increase efficiency of fish streaming line in the case study factory. The results of this study indicated that a bottleneck occurs at the process of pre-cooking. Correction is made by changing the size of raw materials without any effect on material yield before entering the process of pre-cooking. The research results showed that after improvement was made, fish raw material, sizes 1.4-1.8 kg, 3.0-3.4 kg, and 5.0- 6.0 kg could be steamed 67.74 tons/month, 103.22 tons/month, and 72.07 tons/month increasingly accounted for 20%, 33.33%, and 25% respectively. All sizes of fish could be produced greater than 350 tons/month. The improvement made to raw materials before pre-cooking process enables fresh fish head raw material can be sold separately and all sizes of fish had more amount added by 8.33%.

1. Introduction

Thai food industry 2017 in terms of patterns of Thailand' s food exports has potential to be developed to be ready meals or convenience foods increasingly which canned tuna is included in the convenience foods as well. Thai canned tuna export in 2017 was supported from consumers who had demand of processed seafood to make their quality of life better with regard to eating convenience, quick cooking, and complete nutritional values of foods. Food and Agriculture Organization of the United Nation (FAO) expects that in 2025 demand of fish consumption across the world will rise to about 21.8 kg per person, higher from 20.3 kg person in year 2015 [1]. Such situation eventually becomes a significant business opportunity for Thai processed seafood operators. In terms of manufacturing canned tuna, Thai operators have capability and skills in manufacturing canned tuna since skills and technology contributed to the processing have been recognized and complied with international standards. Though Thailand has to import tuna raw material, based on the aforesaid advantage, Thailand can be positioned to be the number one manufacturer and exporter canned tuna in the world.

By the time that business is at risk of costs of production, raw materials, and labor, operators need to increase competitive advantage by focusing on low cost production process, maximize resource utilization, and maximize product yield. Problems most likely found in canned tuna industry that affect efficiency of production process are an oversupply of labor, too much movement in actual work that leads to waste of time in a production process, and limitation in production line, etc. Consequently, operators need to improve and develop efficiency of production process so as to operate and keep pace with current competitive situation.

2. Literature Review

2.1 Literature Review

2.1.1 Productivity

This paper [2] aimed to improve the productivity and efficiency of a vehicle seat assembly line in a local automotive vehicle part manufacturer. The existing vehicle seat assembly line was studied first using a line balancing and simulation approach. The data collected from the existing line are operating time and processes, material handling system, workstation layout and equipment and bill of materials. The productivity and efficiency comparison of the existing assembly line and the proposed assembly line are also highlighted.

This paper [3] aimed to productivity improvement through Lean manufacturing means optimization and coordination of the input

resources to minimize the wastes to reduce total production cost. This can be achieved by Lean thinking and Lean Manufacturing. In this paper researcher has applied lean manufacturing concept in order to increase productivity of coal mining. By application of lean tools the Overall Human Effectiveness is analyzed which is converted into productive output to increase the productivity and develop an overview of the conceptual framework of lean manufacturing practices to minimize the production cost of mining.

2.1.2 Why-Why Analysis

This paper [4] aims to reduce waste of beverage production lines with increasing of operational performance improvement score by brainstorming. After that, evaluating and sorting on priority issues problems by Failure Mode and Effect Analysis (FMEA) and using why-why Analysis technique for guideline to problem solving in all 34 topics of total defects and define 3 implementation solutions to problems plans. Comparison results of operational performance improvement (OPI) before improvement the average was 76.21% and after improvement the average was 83.34% that calculated percentage increasing by 7.13%.

2.1.3 The Seven Quality Control Tools

This paper [5] was to apply some of the 7 QC tools for reducing delay the delivery problem. The Cause and Effect Diagram was found out the root causes of this problem and the Pareto Chart was used to help ordering the important of delay the delivery problem for assigning responsibilities by improving the cause of three reasons: 1.work system 2.work equipment and 3.employees. The results showed that the percentage of operations with reduced error from between 5-10% to 2-3% and [6] this paper was to reduce defects. By using 7 QC Tools in the analysis of the defect problem within the inefficient production process, the causes of the problems in each step of the plastic injection process were considered, categorized and classified. The total production defects of 1,306 units per month can be decreased to 814 units per month. Also, the average defective rate is decreased from 8.52% to 5.37%. The 7QC tools have been developed and implemented in an automobile company to assess and improve the defect reduction level in the assembly line. Chassis and trim lined were selected for data collection to assess and improve the defect level for productivity improvement. It was found from the results that after the successful implementation of the QC tools, the defect level reduced by 90% at the chassis line. Similarly, the defect level was reduced by 80% at the trim line [7-8] and [9] the study of the 7QC tools was applied in an automotive factory in order to

reduce paint shop defects. Within four months the production line was inspected, defects were categorized and the 7QC tools were successfully applied, reducing the overall defect rate by 70%.

3. Methodology

The research was conducted to investigate productivity improvement of canned tuna factory: a case study of pre-cooking line in the production process of canned tuna with the following methods.

3.1 Study production procedure and work procedure in each process

The production and operation procedures in each process include raw material, thawing, butchering, pre-cooking, side-spray, chill room, cleaning, packing, seaming, retorting, labeling, and delivery.

3.2 Analyze to find the cause in the process

Since the pre-cooking process finds a bottle neck, the root causes are analyzed to find out why production capacity cannot reach the goal with why-why analysis and a cause and effect diagram.

3.3 Offer a guideline to solve the problem in the process and operation

From the analysis of limitation in pre-cooking. Operation methods are improved by increasing production capacity. Based on the guideline to solve the problem, productivity of the production line can be improved.

3.4 Improve operation method so as to collect data for making before and after comparison

From receiving information about production, an experiment is made and data of operation are collected to make a comparison of results before and after the improvement.

4. Implementation

4.1 Case study: study current situation of the factory used for the case study

The factory used for this case study is the canned tuna factory. Major raw materials are skipjack tuna, yellow fin tuna, long fin tuna is shown in Figure 1-3. A preliminary study about information in production process indicates that at present production outputs do not balance to production capacity. In addition, the case study factory requires a large number of labors in production process.

Figure 1. Canned tuna

Figure 2. An example of tuna meat in a can

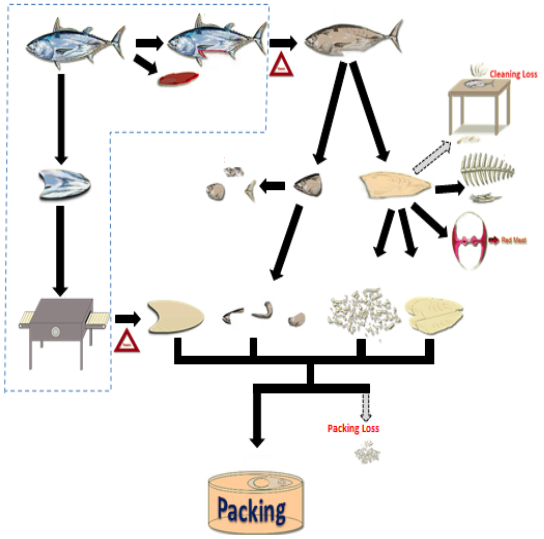

Figure 3. Canned tuna Production process

4.2 The current problems of the case study

Data about production capacity of each production process as shown in Figure 4. shows that production outputs per day do not balance to the overall production process of the factory. Therefore, products cannot meet customers' demands that reach 350 tons/month of raw materials per day. From the mentioned problem, the case study factory has to seek a guideline to improve productivity of the production line. This research makes improvement to increase productivity in different approaches such as improvement of the operation method by designing new operational procedure so that the case study factory can improve its production capacity to meet the set goal.

4.3 The current problems of the case study factory

The case study factory expects the production capacity target at more than 350 tons/month of raw materials per day, with working 2 shifts in one day, 8 hours per shift, 16 hours per day. There are 3 sizes of fish used as raw materials; 1.4 - 1.8 kg; 3.0 - 3.4 kg, and 5.0 - 6.0 kg.

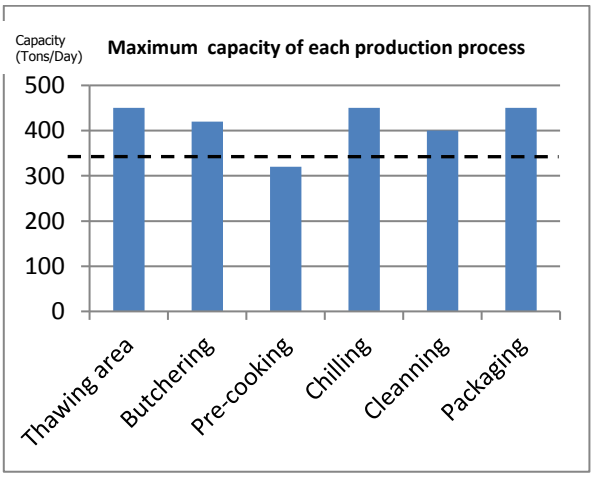

Figure 4. Max. capacity of each production process

Based on the data collection, it can be seen that the procedure that cannot smoothen the production capacity to meet 350 tons/month of raw materials/day is pre-cooking. Pre-cooking is regarded as the bottle neck in this process. As a result, the pre-cooking process will be analyzed later.

4.4 Root cause analysis

Since the pre-cooking process is the bottle neck, root cause is analyzed with why-why analysis method and a cause and effect diagram

to find out what in the pre-cooking process that cannot make the production capacity to reach the set goal.

Based on the finding of root cause with why-why analysis and a cause and effect diagram, it is found that limitation in pre-cooking and limited areas cannot extend or increase numbers of steam pre-cooker. Limitation in pre-cooking is the round of using the pre-cooker. Steaming duration is different depends on each size of fish. Therefore, calculation of steaming round can be described as the problem found in the pre-cooking process.

There are at present 12 pre-cookers, each pre-cooker is loaded with 6 carts, each cart contains 14 grills. Fish will be steamed one size at a time. The calculation of the round of using the pre-cooker is shown in the Table 1.

Table 1. Numbers of steam round per day

Size	Total steam time/round (min)	Total time/day (min)	Numbers of steam (rounds/day)
1.4-1.8	45	960	21
3.0 - 3.4	60	960	16
5.0 - 6.0	75	960	13

Fish sizes 1.4 - 1.8 kg, 3.0 - 3.4 kg, and 3.0 - 3.4 kg can be steamed 21 rounds/ day, 16 rounds/ day, and 13 rounds/ day respectively.

The calculation of steam round based on steaming duration for 8 hours working/kg/shift, 2 shifts /day; 16 hours / day is shown in Table 2.

It can be concluded that the problem is the bottle neck found in the production line at the pre-cooking process. Area cannot be expanded to facilitate more numbers of pre-cookers due to limitation of the area is shown in Figure 5. and Cause and effect diagram at the pre-cooking process in Figure 6.

Table2. Calculation of the capacity in steaming fish in each round before improvement

Size (kg)	Avg. weight (kg)	Qty. (Unit)	Fish Weight (kg)				Total Round	Fish weight/ day (Tons/month)
		Grills	Grills	Carts	Pre-streamer	Round		
1.4-1.8	1.6	10	16	224	1,344.0	16,128.0	21	338.69
3.0-3.4	3.2	6	9.6	268.8	1,612.8	19,353.6	16	309.66
5.0-6.0	5.5	4	6.4	308	1,848.0	22,176.0	13	288.29

4.5 Guidelines for problem solving

Improvement of operation method with increasing production capacity efficiency can be done with the following:

1. Increase numbers of raw materials in a pre-cooker. Since area at the pre-cooking process cannot be expanded due to limitation of area, increased load of fish /cart should be done by decreasing the size of raw materials before entering the pre-cooking process. Based on the brainstorming, it is found that cutting off fish head can increase numbers of fish while arranging them in order. Thus, numbers of fish per steaming round can be increased and result in improving the production capacity.

2. Improve the production line: It aims to be in line with change in the process of raw material preparation for pre-cooking process.

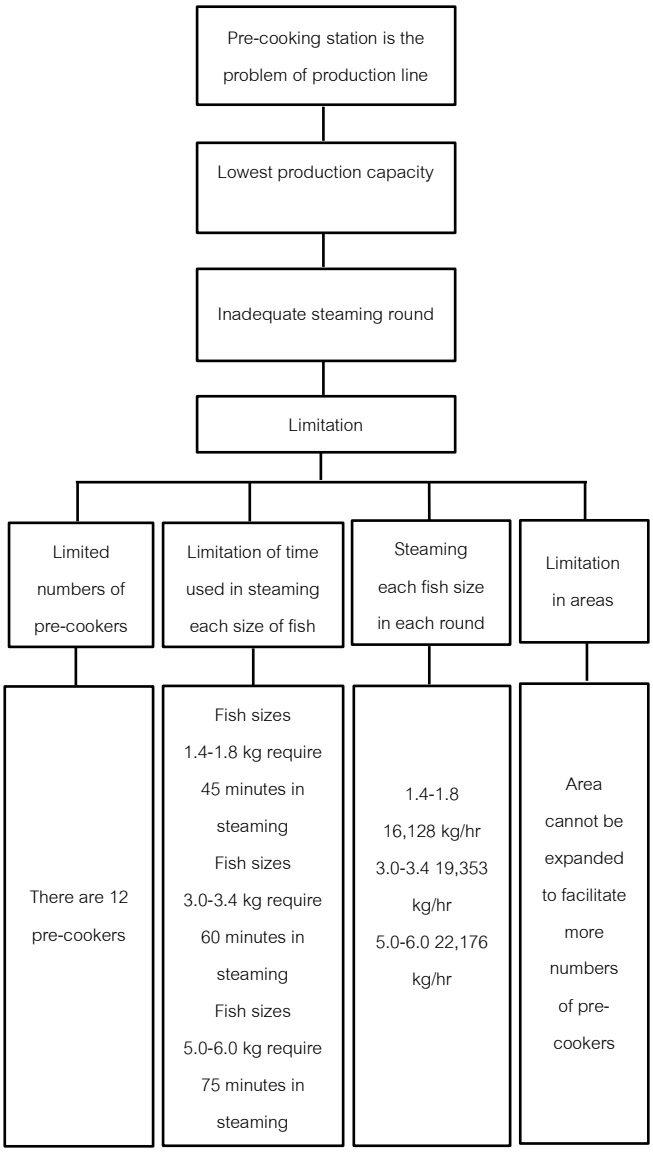

Figure 5: Root cause analysis at the pre-cooking station with why-why analysis

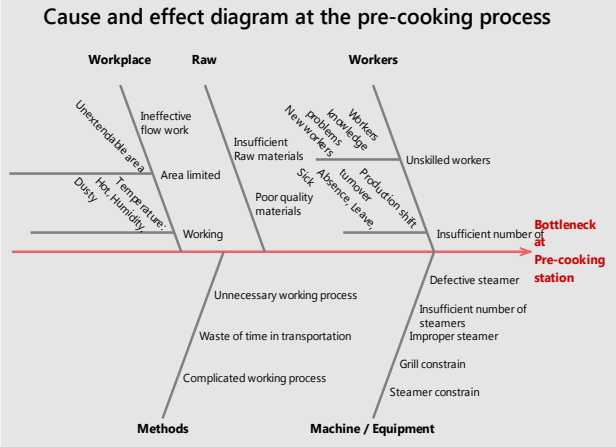

Figure 6: Cause and effect diagram at the pre-cooking process

5. Guidelines for improvement and application

With regard to studying, collecting, and analyzing operational data of every procedure of the production process, it is found that the problem that affects the production capacity of the case study factory is the pre-cooking process. As a result, the research offers guidelines for problem solving so that production capacity efficiency can be increased by reducing the size of fish in the pre-cooking process with cutting off fish head before steaming. The cut fish head can be sold without being processed and the production line is newly arranged to be consistent and supportive with the fish size reduction.

5.1 Reduction of fish size in the pre-cooking process

The reduction of fish size by cutting off fish head before steaming aims to increase

numbers of fish to be steamed in each round of steaming. The figure 7-9 shows arrangement of numbers of fish/grill, in each size, compared to before and after the reduction of fish size.

Figure7. Comparison between original and new arrangement of tuna size 1.4 - 1.8 kg

Figure 8. Comparison between original and new arrangement of tuna size 3.0 – 3.4 kg

Figure 9. Comparison between original and new arrangement of tuna size 5.0 – 6.0 kg

The reduction of fish size before steaming can increase numbers of fish in each round of steaming as shown in the Table 3.

Table 3. The calculation of capacity of fish steaming in each round after the improvement

Size (kg)	Avg. weight (kg)	Qty. (Unit)	Fish Weight (kg)				Total Round	Fish weight/ day (Tons/month)
		Grills	Grills	Carts	Pre-streamer	Round		
1.4-1.8	1.6	12	19.2	268.8	1,612.8	19,353.6	21	406.43
3.0-3.4	3.2	8	12.8	358.4	2,150.4	25,804.8	16	412.88
5.0-6.0	5.5	5	8	385.0	2,310.0	27,720.0	13	360.36

5.2 Yield testing with the reduction of fish size before steaming

After fish size is reduced and the pattern of arranging fish that are cut off their heads is changed, yield percentage is collected for a month. The experimental result shows the reduction of fish size by cutting fish heads does affect yield percentage and calculating yield example is shown in the Table 4- 5.

5.3 Newly organized production line

With regard to changing in raw materials used before the pre-cooking process, some procedures have to be changed to support newly organized production line and manpower to facilitate in each related station is newly calculated which include:

5.3.1 Butchering station

At present there are 9 workers working at the butchering station. Working capability is 1,200 kg/person/hour. In relation to fish head cutting machine, numbers of workers should be 8 persons. After the improvement is made there are 21 workers taking charge of the butchering station and 16 workers at the fish head cutting machine station.

Table 4. Yield percentage after changing arrangement of tuna that are cut off their heads

Yield Test							
dd/mm/yy	% Yield [STD : 44.6 %]			dd/mm/yy	% Yield [STD : 44.6 %]		
	1.4 - 1.6 kg	3.0 - 3.4 kg	5.0 - 6.0 kg		1.4 - 1.6 kg	3.0 - 3.4 kg	5.0 - 6.0 kg
1/8/17	48.90	48.85	48.86	19/8/17	49.07	48.10	48.86
	48.78	48.82	48.91		48.85	48.46	48.89
2/8/17	49.07	48.10	48.86	21/8/17	48.80	48.10	47.36
	48.85	48.46	48.89		48.11	48.07	46.69
3/8/17	48.80	48.10	47.36	22/8/17	49.20	48.12	48.33
	48.11	48.07	46.69		48.48	47.22	48.96
4/8/17	48.90	48.85	48.86	23/8/17	48.90	48.85	48.86
	48.78	48.82	48.91		48.78	48.82	48.91
5/8/17	47.89	46.65	46.96	24/8/17	48.80	48.10	47.36
	48.72	48.82	46.03		48.11	48.07	46.69
7/8/17	47.58	48.01	48.20	25/8/17	47.49	47.37	46.68
	47.90	48.37	48.89		47.95	47.41	46.72
8/8/17	48.89	48.10	47.37	26/8/17	47.04	46.31	47.44
	48.86	48.07	46.70		47.43	47.36	47.19
9/8/17	48.88	46.93	46.22	28/8/17	47.49	46.93	46.22
	48.91	48.46	46.82		46.94	48.46	46.82
10/8/17	49.20	48.12	48.33	29/8/17	48.90	48.85	48.86
	48.48	47.22	48.96		48.78	48.82	48.91
11/8/17	46.83	47.25	46.79	30/8/17	48.80	48.10	47.36
	47.34	47.18	46.99		48.11	48.07	46.69
14/8/17	47.39	47.27	46.47	31/8/17	47.89	46.65	46.96
	47.45	47.48	46.31		48.72	48.82	46.03
15/8/17	47.49	47.37	46.68	1/9/17	47.58	48.01	48.20
	47.95	47.41	46.72		47.90	48.37	48.89
16/8/17	47.04	46.31	47.44	2/9/17	49.20	48.12	48.33
	47.43	47.36	47.19		48.48	47.22	48.96
17/8/17	47.49	46.93	46.22	5/9/17	49.07	48.10	48.86
	46.94	48.46	46.82		48.85	48.46	48.89
18/8/17	47.39	46.88	46.47	Avg.	48.23	47.89	47.61
	47.45	47.39	46.31				

Table 5. Calculating yield example

Fish Size	Date : 5/6/2561 Time : 8.00 AM Size : 1.4 - 1.6 kg.						
BBT. (Before Cook)	-2.6	-1.5	-2.5	-1.6	-2.3	-1.8	-1.84
	-1.8	-2.3	-2.4	-1.6	-1.3	-2.6	
	1.2	-2.8	-2.2	-1.0	-2.5	-1.5	
BBT. (After Cook)	58.0	60.1	62.0	59.6	61.1	59.6	59.13
	55.1	60.0	61.9	59.9	58.5	55.6	
	62.0	62.9	54.6	58.6	58.8	56.1	
BBT. (After Spray)	46.6	47.8	45.9	48.8	49.3	47.5	47.65
	48.9	49.5	48.8	47.9	46.9	48.8	
	49.3	47.8	48.8	47.9	48.5	47.5	

Fish Preparation	kg	%Recovery	% Loss	
Round Wt. (Kgs)	1000.00	100.00%	-	
Thaw Wt. (Kgs)	998.43	99.84%	-0.16%	-7.15%
Butcher Wt. (Kgs)	898.59	89.86%	-6.99%	
Bellies Wt. (Kgs)	29.95	3.00%		
Viscera (Kgs.)	69.89	6.99%		
Unaccounted		-	0	
Cook Wt. (Kgs.)	825.36	82.5%	-7.32%	
Cool Wt. (Kgs.)	823.45	82.3%	-0.19%	
Fog Wt. (Kgs.)	821.62	82.2%	-0.18%	
Belly Cook/Cool Wt.	27.30	2.73%	-0.27%	
WT. Before Cleanning	848.92	84.89%	-7.96%	
Loin Cleaning	kg	Pct		
Loin (Kgs.)	396.54	39.65%		
Flake	12.10	1.21%		
Belly (Kgs.)	17.40	1.74%		
Total loin		42.61%		
Shredded (Kgs.)	47.50	4.75%		
Gill (kgs)	12.20	1.22%		
head (kgs)	3.20	0.32%		
Total shredded		6.29%		
Total Tuna	476.84	48.90%		
Red Meat (Kgs.)	91.20	9.12%		
Skin (Kgs.)	56.40	5.64%		
Head	85.00	8.51%		
Bone (Kgs.)	24.30	2.43%		
By-Product (Kgs.)	165.70	16.58%		
Total Misc	256.90	25.70%		

5.3.2 Pre-cooking station

Currently there are 9 workers per day who take charge of arranging fish on grills. Working capability is 2,200 kg/person/hour. After the improvement is made, there are 11 workers working at the pre-cooking station.

5.3.3 Cleaning station

Typically, there are 1,116 workers who can work with 35 kg/person/hour. After improvement is made by cutting off fish heads, staff can work increasingly with 40 kg/person/hour. So, the total numbers of workers are:

= 350,000/4/8 = 1,094 persons

It can be concluded that after the improvement, workers at the cleaning station decreases by 22 persons while workers can be rotated to other stations that require more people such as the butchering and pre-cooking stations as shown in the Table 6.

Table 6. Summary of numbers of workers before and after the improvement

Process	Before improvement	After improvement	Remark
Butchering	9	21	-
Cutting head	8	16	-
Pre-cooking	9	11	-
Cleaning	1,116	1,094	Over 22 persons shift to work others process
Total	1,142	1,142	

5.4 Economic estimation

5.4.1 Calculation of efficiency of the pre-cooking process after the improvement

After the improvement is made by cutting fish heads before the pre-cooking process, it is found that the weight of fish raw materials can be increased; fish sizes 1.4 - 1.8 kg are increased by 67.74 tons/month accounted for 20%, fish sizes 3.0 - 3.4 kg are increased by 103.22 tons/month accounted for 33.33%, and fish sizes 5.0 - 6.0 kg can be increased by 72.07 tons/month accounted for 25%. All sizes of fish can be produced more

than 350 tons/month of raw materials as shown in the Table 7.

Table 7. All sizes of fish can be produced more than 350 tons/month of raw materials

Size (kg)	Qty./Grill (Units)		Fish weight/day (Tons/month)		Increasing fish weight/day	
	Before improvement	After improvement	Before improvement	After improvement	Tons/month	%
1.4-1.8	10	12	338.69	406.43	67.74	20.00
3.0-3.4	6	8	309.66	412.88	103.22	33.33
5.0-6.0	4	5	288.29	360.36	72.07	25.00

5.4.2 Comparison of fish amount before and after the improvement

Comparison of fish amount after the improvement will be calculated from the gross weight of fish raw materials after the improvement as shown in the Table 8-10.

Table 8. Fish amount before the improvement

Size (kg)	Steam fish	
	Total weight (kg/day)	Amount 6 baht /kg
1.4-1.8	406,430	2,438,580
3.0-3.4	412,880	2,477,280
5.0-6.0	360,360	2,162,160

With regard to the improvement process made to cutting fish heads before the pre-cooking process, the steamed fish can be sold at 6 baht per kilogram and fresh fish heads are sold at 8.50 baht per kilogram. The weight of fish body is accounted for 80% of the whole fish weight and the weight of fish head is accounted for 20% of the whole fish weight. The fish amount after the improvement is made can be seen in the Table 9.

Table 9. Fish amount after the improvement

Size (kg)	Body		Head		Total Amount (baht)
	Weight (kg)	Amount (baht)	Weight (kg)	Amount (baht)	
1.4-1.8	325,144	1,950,864	81,286	690,931	2,641,795
3.0-3.4	330,304	1,981,824	82,576	701,896	2,683,720
5.0-6.0	288,288	1,729,728	72,072	612,612	2,342,340

The amount of fish before and after the improvement is compared to find changing amount as seen in the Table 10.

Table 10: The amount comparison between before and after the improvement

Size (kg)	Amount before improvement (baht)	Amount after Improvement (baht)	Amount different (baht)	Amount different (%)
1.4-1.8	2,438,580	2,641,795	203,215	8.33
3.0-3.4	2,477,280	2,683,720	206,440	8.33
5.0-6.0	2,162,160	2,342,340	180,180	8.33

Amount of fish after the improvement is made to fish size are shown as follow: fish sizes 1.4 - 1.8 kg are accounted for 203,215 baht, fish sizes 3.0 - 3.4 kg are accounted for 206,440 baht, and fish sizes 5.0 - 6.0 kg are accounted for 180,180 baht, or accounted for increased amount by 8.33% for all sizes of fish.

6. Conclusions, recommendations, and future research

6.1 Conclusions

This research aims to improve the production efficiency so as to increase production capacity to be greater than 350 tons/month of raw materials per day. It is

noticeable that the problem is found at the pre-cooking process that cannot facilitate raw materials higher than 350 tons/month. Therefore, the bottleneck occurs at this station. The researcher then offers problem solution by reducing the size of raw materials before entering the pre-cooking process by cutting off fish heads which can increase more number of fish in arrangement. Therefore, the numbers of fish per each steaming round are increased which results in greater production capacity. In the meantime balance is made in the newly organized production line by using the same numbers of staff. The experiment indicates that cutting off fish heads does not affect yield percentage and after the improvement is made, it is found that cutting fish heads before the pre-cooking process can allow more numbers of fish to be steamed as fish raw material sizes 1.4-1.8 kg, 3.0-3.4 kg, and 5.0-6.0 kg could be steamed 67.74 tons/month, 103.22 tons/month, and 72.07 tons/month increasingly accounted for 20%, 33.33%, and 25% respectively. All sizes of fish can be produced greater than 350 tons/month of raw materials. The improvement of raw materials before pre-cooking process enables the factory to separately sell fresh fish heads which gives more amount to all sizes of fish by 8.33%. The linkage among problem, solution and result shown in the Table 11.

Table 11: The linkage among problem, solution and result

Problem	Solution	Result
Bottleneck at the pre-cooking process	Reducing the size of raw materials before entering the pre-cooking process by cutting off fish heads which can increase the fish's number in arrangement	Increase production capacity

6.2 Suggestions

This research is conducted in the parts of raw materials and production line only while other factors probably have effect on improvement of the production efficiency such as duration of fish steaming or working standard of workers that may have direct impact on the overall cost and efficiency.

6.3 Future research

The case study factory will be able to increase production efficiency because of since at the moment human workers are mainly used. A study may be conducted about employing machines and equipment to increase production efficiency. A study about other factors that may affect improvement of production efficiency should be conducted such as duration of fish steaming or working standard of workers. Guidelines in improving productivity of the case study factory can be applied to other factories producing similar or relevant products. Since numbers of fish can be changed, there should be a study conducting about energy consumption in

fish steaming to see how it can have an impact on the production cost.

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