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นางสาว ชลลญา โชติเวทธำรง

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PRODUCTION TIME LOSS REDUCTION IN AN ICE-CREAM FACTORY

Miss Chollaya Chotivetthamrong

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By	Miss Chollaya Chotivetthamrong
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Thesis Advisor	Jittra Rukijkanpanich, D. Eng.

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.....Chairman
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.....Thesis Advisor
(Associate Professor Jittra Rukijkanpanich, D. Eng.)

.....Member
(Assistant Professor Manop Reodecha, Ph.D.)

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ในขณะที่ปริมาณความต้องการไอศกรีมมีมากขึ้นทุกปี โรงงานจึงต้องทำการปรับปรุงเพื่อให้สนองความต้องการของลูกค้าให้ได้ จากการสำรวจปัญหาพบว่าโรงงานไม่สามารถผลิตได้เพียงพอกับความต้องการของลูกค้า โดยเบื้องต้นพบว่า การกำหนดปริมาณการผลิตในอุดมคติมีค่าต่ำ อันเนื่องมาจากระยะเวลาที่ใช้ในการผลิตต่อรอบนาน การกำหนดปริมาณการผลิตในอุดมคติของดังกล่าว คิดเป็น 90% ของปริมาณการผลิตสูงสุดของเครื่องจักร ส่งผลปริมาณที่ผลิตได้มีจำนวนน้อย และเมื่อทำการศึกษาถึงสาเหตุของการที่ใช้เวลาในการผลิตนานนั้น พบว่าเกิดจากเวลาสูญเสียที่เกิดขึ้นในกระบวนการผลิต ดังนั้นในการศึกษานี้จึงสนใจที่จะปรับปรุงการทำงานให้สามารถเพิ่มปริมาณการผลิตได้ โดยมีวัตถุประสงค์เพื่อลดเวลาสูญเสียในการผลิตไอศกรีม และศึกษาเฉพาะที่กระบวนการผลิตไอกรีมแท่งเพราะมีปริมาณการผลิตสูง

จากการศึกษาจะได้ว่าเวลาสูญเสียหลักในกระบวนการผลิต เกิดจากเวลาตั้งเครื่อง และเวลาในการทำให้ไอศกรีมแข็งตัว โดยขั้นตอนแรกของการศึกษานี้เริ่มจาก การเก็บข้อมูลและการนำข้อมูลดังกล่าวมาทำการวิเคราะห์ โดยใช้วิธี Why-why analysis เพื่อหาสาเหตุที่แท้จริง ซึ่งสามารถสรุปได้ว่า ในกระบวนการตั้งเครื่องนั้นมีขั้นตอนการทำงานไร้ประสิทธิภาพอยู่เป็นจำนวนมาก ส่วนในกระบวนการทำให้ไอศกรีมแข็งตัวนั้นสาเหตุเกิดจากการใช้ตัวทำความเย็นที่ไม่เหมาะสม จึงใช้เวลามากไม่เพียงแต่เวลาในการถ่ายเทความร้อน แต่รวมถึงกระบวนการตั้งจุดแข็งตัวที่เหมาะสม ต่อมาทำการวางแผนปรับปรุงในกระบวนการตั้งเครื่องและกระบวนการทำให้ไอศกรีมแข็งตัว โดยใช้เทคนิค ECRS โดยเทคนิคนี้ไม่เพียงแต่จะปรับปรุงกระบวนการทำงานแต่ก็รวมถึงการพัฒนาอุปกรณ์เครื่องใช้ที่ช่วยในการทำงานด้วย หลังจากนั้น จึงทำการวิเคราะห์ทางด้านเศรษฐศาสตร์ จากการวิเคราะห์ผลทั้งหมด สามารถสรุปได้ว่าบริษัทควรลงทุนในกระบวนการตั้งเครื่องเพียงอย่างเดียว เพราะหลังจากที่ได้ทำการประยุกต์ใช้ สามารถลดเวลาในการตั้งเครื่องจาก 6.90 ชั่วโมงต่อรอบการผลิต เหลือเพียง 2.43 ชั่วโมงต่อรอบการผลิต หรือคิดเป็นร้อยละ 64.78 ทั้งนี้มีค่าต้นทุนการผลิตต่อหน่วยลดลงจาก 148.75 บาทต่อลิตร เป็น 123 บาทต่อลิตร หรือคิดเป็นร้อยละ 17.31 จากการปรับปรุงดังกล่าวส่งผลให้ปริมาณการผลิตในอุดมคติมีค่าเพิ่มขึ้นประมาณ 5 เท่าซึ่งสามารถรองรับความต้องการของลูกค้าไม่เพียงแต่ปีนี้เท่านั้นแต่ยังรองรับความต้องการที่ได้คาดการณ์ไว้ล่วงหน้าด้วย

ภาควิชา ศูนย์ระดับภูมิภาคทางวิศวกรรมระบบการผลิต ลายมือชื่อนิสิต .....
สาขาวิชา .....การจัดการทางวิศวกรรม..... ลายมือชื่ออาจารย์ที่ปรึกษา .....
ปีการศึกษา .....2549.....

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KEY WORD: PRODUCT TIME / LOSS REDUCTION/ ICE-CREAM FACTORY

CHOLLAYA CHOTIVETTHAMRONG: PRODUCTION TIME LOSS REDUCTION IN AN ICE-CREAM FACTORY. THESIS ADVISOR: ASSOC. PROF. JITTRA RUKIJKANPANICH, D.ENG. 152 pp. ISBN 974-14-2750-6

Ice-cream's demands are increasing every year. The factory needs improvement in order to support customers' demands. From identifying the problem, it was found that the factory could not meet the customers' demands because the ideal production volume was low. This type of volume is 90% of the maximum production volume. Because of long production time per cycle, the ideal volume is low and unable to meet customers' demands. The main cause effects both production time and production volume is the production time loss. Therefore, this study is interested in production improvement. The objective of this study is to reduce the production time losses in the stick line that has the most serious demands.

From studying, there are two main loss times in a production process. They are set up time and freezing time. First of all, should collect data, and analyse them by using why-why analysis in order to know the root causes. From the why-why analysis, it was shown there are a number of ineffective procedures in the set up process. These procedures spent a long time. In the freezing process, it uses an unsuitable freezing agent, which takes a long time not only in transferring heat but also getting the appropriate freezing point. After that, plan to improve the set up process and freezing process by applying ECRS technique. This technique is not only improves procedures but also develops helpful equipment. Then, analyse by economic evaluation. From this evaluation, it can conclude that the company should invest only in changeover project. After the implementation, the improved processes can reduce set up time from 6.90 hrs per production cycle to 2.43 hrs per production cycle or about 64.78% while the manufacturing cost can reduce from 148.75 Baht per liter to 123 Baht per liter or approximately 17.31%. For that reason, ideal production volumes are increased about 5 times, which are not only can support this year's demands but also the forecasting's.

Department The Regional Centre for Manufacturing Systems Engineering Student's signature .....
Field of study ..... Engineering Management ..... Advisor's signature JITTRA R
Academic Year ..... 2006 .....

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CHAPTER I

INTRODUCTION

1.1 Background of the research

“Since the 1950s, competition between companies has increased as markets have become increasingly global” (B. and Grunberg, 2001). For that reason, every company, facing increasing competitive pressure, has to improve their manufacturing performance to get higher market share especially in the ice-cream business.

“In the past, the global ice cream market remained rather fragmented compared to other food sectors. The sales growth had stagnated in many regions worldwide; however, nowadays the manufacturers improve their products to be more innovation, higher-quality and cheaper. Thus, the global ice-cream’s trend changes to be stronger growth characteristics." (Just-Food, 2006). Moreover, it still increases continuously, shown in figure 1.1.

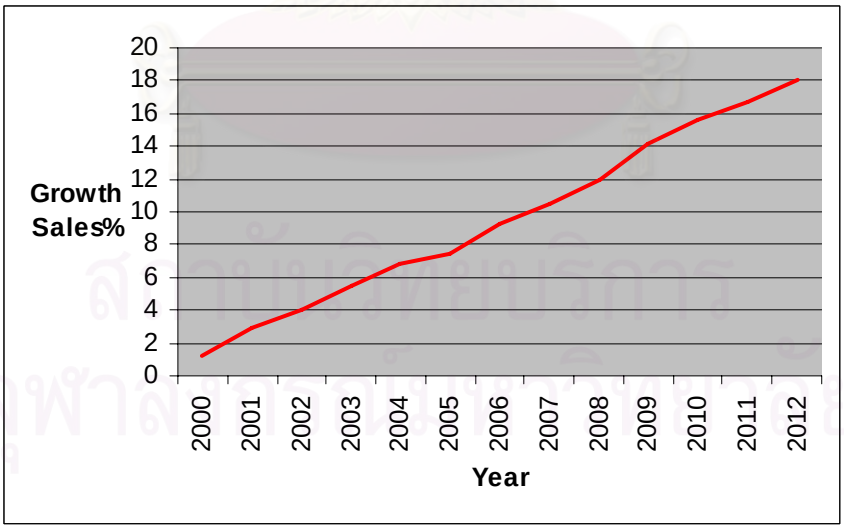


Figure 1.1: Ice-cream trend (Just-Food, 2006)

From figure 1.1, its sales growth increases significantly. It can conclude that ice-cream business produces the coldest product, but becomes one of the hottest businesses. Hence, for getting competitive advantage, company should consider on producing high quality products faster than its competitors.

Every ice-cream company tries to find the best way to produce the right product, which matches to its customers' requirement, at the right place in the right time, which also quicker than its competitors, at the right amount.

For supporting of previous idea, since ice-cream company uses continuous process by automatic machine, the company should increase its machine capacity to produce its products in high productivity, and can support its products whenever its customers want.

A case study company is one of the leading ice-cream manufacturer companies. It was found in 1989 at Min Buti (Lardkarbang industrial park), which has 45,000 m^2 areas, with the purpose of producing high-quality products. It produces more than 40 products for domestic and overseas consumptions such as United Kingdom, Italy, Brazil, Netherland, and also the Asian countries.

1.2 Production process

"**Ice cream** (originally **iced cream**) is a frozen dessert made from dairy products such as cream (or substituted ingredients), combined with flavourings and sweeteners such as sugar." (Wikipedia, 2006).

"Modern industrially-produced ice-cream is made from a mixture of ingredients (Wikipedia, 2006):

- 10-16% milk fat
- 9-12% milk solids-not-fat: this component, also known as the serum solids, contains the proteins (caseins and whey proteins) and carbohydrates (lactose) found in milk
- 12-16% sweeteners: usually a combination of sucrose and/or glucose-based corn syrup sweeteners
- 0.2-0.5% stabilizers and emulsifiers e.g., agar or carrageenan extracted from seaweed
- 55-64% water which comes from milk solids or other ingredients"

There are seven ice-cream production procedures, discussing in the following, shown in figure 1.2:

1. Receive all of raw materials from suppliers such as milk, cream & butter, sucrose/glucose, and stabilizers, which are the most important ingredients, because “it is a chemical that is added to a solution or mixture or suspension to maintain ice-cream in a stable or unchanging state.” (die.net, 1998).
2. Put all of the ingredients into the mix tank to be ice-cream mix.
3. Put ice-cream mix into the homoginiser and pasteurization to maintain ingredient to be stable, and to kill the microbial, which is the most dangerous bacteria in iced food.

   “Homoginiser is a fluid mechanical process that involves the subdivision of particles or droplets into micron sizes to create a stable dispersion or emulsion for further processing. This is an important stage in the treatment of food and dairy products. It provides improved product stability, shelf life, digestion, and taste.” (Niro Soavi, 2006).

   “Pasteurization is a process of heating a liquid, particularly milk, to a temperature between 55 and 70 degrees C (131 and 158 degrees F), to destroy harmful bacteria without materially changing the composition, flavor, or nutritive value of the liquid. This process is heating about 30 minutes and rapidly cooling it.” (Microsoft Cooperation, 1998).

4. Then put ice-cream mix into the aging tank “at least four hours for the fat to cool down and crystallize, and for the proteins and polysaccharides to fully hydrate.” (University of Guelph, 1995).
5. Add colour and flavour into the mix at colour/ flavour vat.
6. Then pump the mix into the freezer to pump air into the ice-cream. “Ice cream should contain a considerable quantity of air, up to half of its volume. This gives the product its characteristic lightness. Without air, ice cream would be similar to a frozen ice cube.” (University of Guelph, 1995), and then soft-serve ice-cream will go to the production phase that is going to packaging and quality control to produce products like customers’ specification.
7. Transport products to customer by using frozen storage, which maintain -18°C like in the freezer to keep the same flavour.

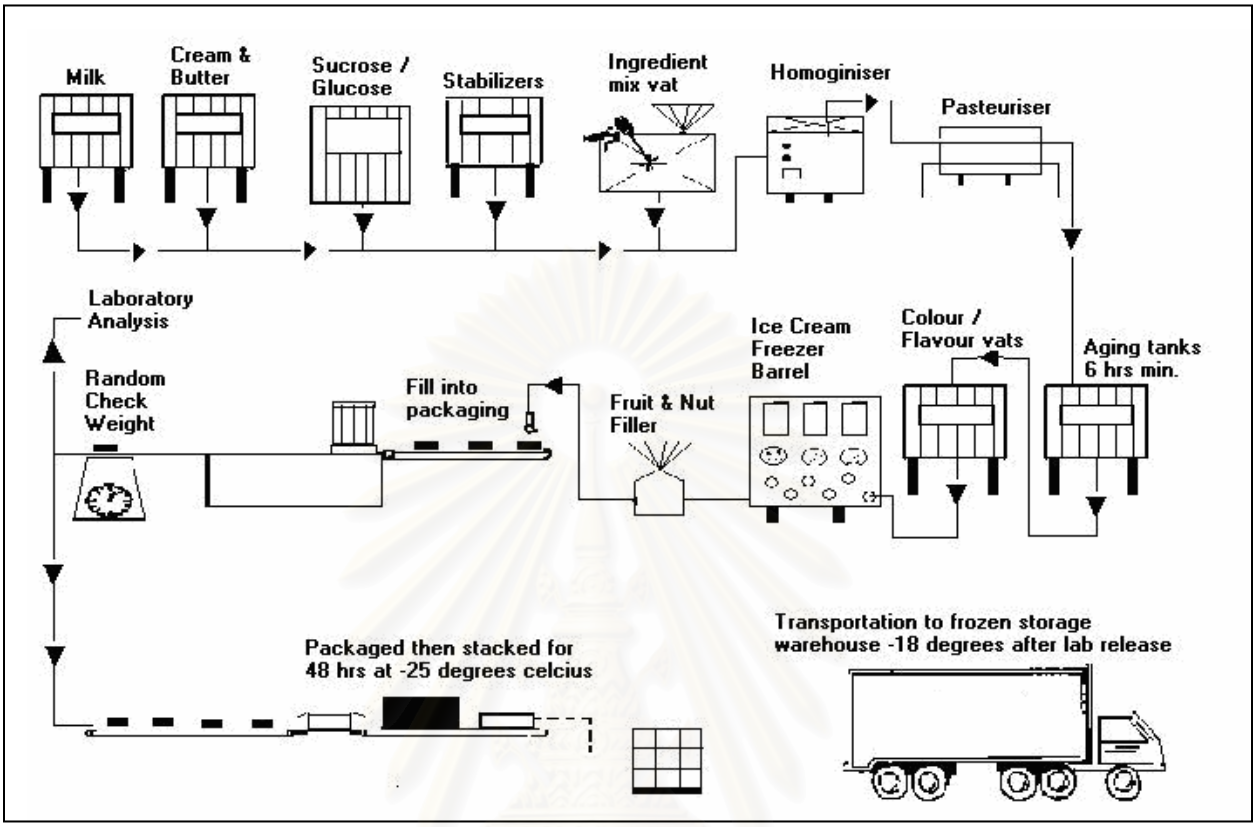


Figure 1.2: ice-cream production process flow (Norco, 2004)

1.3 Problem statement

The business processes of the company starts at the administration department to plan the production volumes and send them to the factory department to produce products and send them to the customers.

Each function has different duty, which also supports overall company's objectives. However, the control of production is the responsibility of the packing department. In the packing department, its process starts from receiving planned volumes to form and package products, and then sends products to logistic department for sending them to the customers.

The current critical problem of the company is unsupportable product, defining that cannot support products to meet planned volumes. This problem highly effects to the customers' satisfaction, shown in table 1.1.

Table 1.1: Unsupportable products problem

Summary 2006													
Stick (TL)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Planned volume	1125	998	1147	1374	1117	969	1033	908	893	1389	996	965	12914
Actual production volume	1102	990	1137	1241	1100	956	1009	904	889	1245	989	961	12524
Unsupported volume	23	8	10	133	17	13	24	4	4	144	7	4	391
Cup (TL)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Planned volume	780	640	1100	1210	810	610	680	580	480	1180	720	610	9400
Actual production volume	780	640	1100	1210	810	610	680	580	480	1180	720	610	9400
Unsupported volume	0	0	0	0	0	0	0	0	0	0	0	0	0
Cone (TL)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Planned volume	450	350	580	610	530	480	510	430	320	670	560	420	5910
Actual production volume	450	350	580	610	530	480	510	430	320	670	560	420	5910
Unsupported volume	0	0	0	0	0	0	0	0	0	0	0	0	0

From table 1.1, it compares between the planned volumes and actual production volumes, referring to the production volumes in the real time. Therefore, it can conclude that the company cannot support the planned volumes only in stick products obviously in peak periods that are in April and October. This problem occurs, because the stick lines produce the variety of products. Thus, even the planned volumes are small number there are more production time loss than the others.

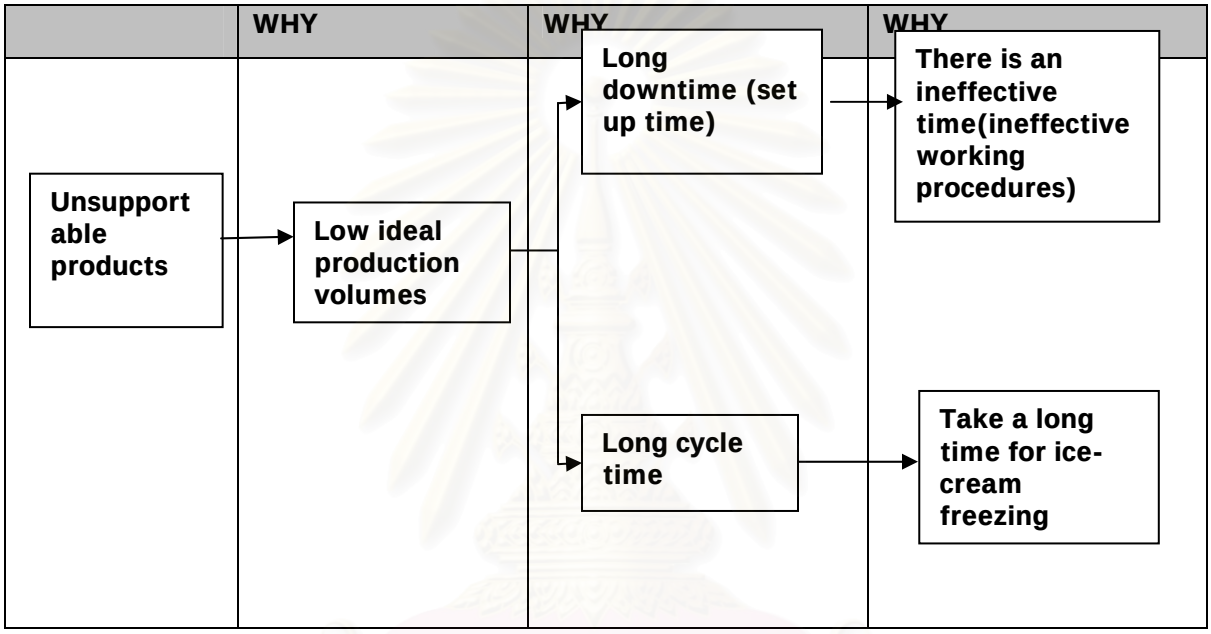
Since the critical problem occurs in only stick production lines, for solving this problem, should consider only these lines. First of all, have to understand these lines' time loss to know why the problem occurs, shown in table 1.2.

Table 1.2: Time loss in stick lines

Summary 2006						
No.	**Description**	**Downtime**		**Total**	**%**	**%Parato**
		Minutes	**Frequency**			
1	Cleaning	3,050	36	109,800	64.48	64.48
2	Freezing	2,510	23	57,730	33.90	98.39
3	Breakdown : Belt	450	2	900	0.53	98.91
4	Utility : (Electric - Supply Failure)	240	3	720	0.42	99.34
9	Adjustment : Start up	60	6	360	0.21	99.55
5	Meeting	130	2	260	0.15	99.70
6	Machine Checking	120	2	240	0.14	99.84
7	Adjustment : After Start up	40	4	160	0.09	99.94
8	Breakdown : Warm Brine : Warm Brine Coil	100	1	100	0.06	99.99
9	Utility : (Air - Compressor Failure)	10	1	10	0.01	100.00

From table 1.2, it can conclude that the main reasons of time loss in stick lines come from cleaning and freezing time, which can analyse to find the root causes of problem by using why-why analysis, shown in table 1.3.

Table 1.3: Why-why analysis for unsupportable products problem



From table 1.3, it can conclude that the root cause of unsupportable product is low ideal production volumes, which mean that when using machine about 90% of its capacity, it can produce a low number of production volumes. The ideal production volumes of stick lines are shown in table 1.4.

Table 1.4: Stick's ideal production volumes

Lines	Ideal production Volumes (Megaliter, ML/month)
Line X	309.66
Line Y	281.07
Line Z	571.68

These ideal production volumes can calculate by multiplying production hours per month, product's weight and number of products in each production time. Thus, it can summary that the ideal production volumes have two factors that are production hours and number of production products, because the product's weight is a constant. To increase all of these factors, should minimize production time losses especially a long set up time and a long cycle time.

1. Long set up time

All of the stick lines use the same machines, but produce different products, divided by raw material. Therefore, for solving effectively, should solve the most serious problem, because if solve the most serious line, the others will be solved too. Hence, in this research, concentrates on only the most serious line.

Since microbial can multiple in ice-cream easily, the company should clean its machine all the time when changing product. Thus, the machine, which produces more type of product, will be affected by changeover problem a lot. The stick production lines are shown in table 1.5.

Table 1.5: Stick Line production

Stick Line	Number of product types
Line X	25
Line Y	15
Line Z	14

From table 1.5, it can conclude that line X produces a lot of types of products that are about 25 products. Thus, line X will get the most serious changeover problem. From this reason, it can conclude that line X will have an amount of production time loss, which highly effects to over machine's ideal production volumes problem when compare with planned volumes, shown in table 1.6.

Table 1.6: Over ideal production volumes

Summary 2006			Over ideal production volume									
Stick X	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	257	268	403	507	451	410	400	320	328	439	378	356
Stick Y	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	342	200	199	214	206	213	242	197	197	246	197	197
Stick Z	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	526	531	445	552	460	346	391	391	367	474	422	412
Summary 2007												
Stick X	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	237	211	224	331	234	198	240	206	189	269	218	217
Stick Y	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	212	189	200	297	209	177	215	185	169	241	196	194
Stick Z	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	379	338	358	531	375	317	384	330	303	432	350	348
Summary 2008												
Stick X	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	620	553	585	867	612	517	627	540	495	705	572	568
Stick Y	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	220	197	208	308	218	184	223	192	176	251	203	202
Stick Z	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	407	363	384	569	402	340	412	354	325	463	375	373

From table 1.5 and 1.6, it can conclude that in x production line, there is the most serious problem to produce products following the planned volumes. Most of its production plan volumes are over machine's ideal production volumes. For increasing stick's ideal production volumes, have to minimize the set up time in the line X first.

2. Long cycle time

Since Thailand is a hot country, freezing ice-cream will take about several hours. Moreover, the existing freezing process uses salt water to transfer the heat in mixed ice-cream, which also takes an amount of time. Hence, the company will get a long cycle time. To increase ideal production volumes, should reduce cycle time by minimizing freezing time.

1.4 Objective of the research

The objective of this thesis is to reduce production time loss from set up time and freezing time in stick line of an ice-cream factory.

1.5 Expected benefits of the research

This section presents advantage of this research:

- To improve production processes by setup time reduction by doing quick changeover, and the better way of quick ice-cream freezing.
- To provide information and suggestion for production time loss reduction.
- To guide about reducing production time loss for the similar industries.

1.6 Scope of the thesis

This research will propose quick changeover and freezing methods, including equipment and procedures, and its rationalization in forming and packaging processes of stick line.

1.7 Research procedure

This section presents the plan for reaching the objective in the previous section. There are a lot of strategies for trouble-shooting this problem, so have to consider which one is the best solution, not only for the short term but also for the long term. For that reason, in this research, will discuss two common methods. All of the procedures are shown by following:

1. Study the process of producing ice cream in the line.
2. Analyze and summarize the previous data to determine the causal relationships among the problem and WHY-WHY Analysis to know the root cause.
3. Eliminate the problem by using two most frequent methods that are doing quick changeover and speeding up, and study forecasting demand.

- To reduce set up time: Do quick changeover by using ECRS that are improving working processes or using automated machines or facilitating equipment to help workers to do their job.

  Since ice cream is a consumable product, its quality is one of the most important things, especially keeping products free from microbial because

"Microbial found in food can lead to food poisoning which can be dangerous. Bacteria multiply fast and to do so need moisture, food, warmth and time. The presence or absence of oxygen, salt, sugar and the acidity of the surroundings are also important factors. In the right conditions, one organism can multiply to more than four million in just eight hours. They multiply best between five to sixty-three °C" (Foodlink, 2002).

For getting high quality products, company has to clean the machine all the time when changing products or using machines for 60 to 90 minutes to protect the ice cream from germ. For this reason, the company loses a lot of time to clean machine, which effects to produce product in time.

In order to solve this problem, the companies need to reduce their set-up time by finding the cause of problem. This will also help the companies to reduce their unnecessary costs and sell at a lower price.

- To reduce ice-cream freezing time: Speed up by using chemical component such as liquid nitrogen.

"Nitrogen is about 78% of the volume of the atmosphere and has a boiling temperature of one hundred and ninety five point eight degrees below zero Celsius." (MCl's CoolClixx, 1997).

Therefore, liquid nitrogen is not only easy to find but also help to freeze ice-cream faster. However, liquid nitrogen is also dangerous, because "The truth of the matter is that the human body is so hot to the Liquid Nitrogen that it will boil in your hand with out any harm to you." (MCl's CoolCixx, 1997). For that reason, for using this chemistry, the company will remember that do not let employee touch it.

4. Predict the effects on the manufacturing costs, including all potential costs, discussing by the following, by using Cost-Benefit analysis, and do feasibility study and give some suggestion for expensive equipment:
    - Purchase of any equipment or processes
    - Installation of equipment and/or implementation of new processes
    - Down-time in the use of old equipment and/or processes while the new equipment and/or processes is put into use

- Staff training in the use of new equipment and/or processes
- Rate of impure products, if this rate increases with the new equipment and/or process
- Management time used to select, install and implement the new equipment and/or processes
- Electricity consumption, if the rate increases with the new equipment and/or processes
- Extra units of ice-cream produces using the new equipment and/or processes

5. Select the best solution, which returns the highest profit to the company.
6. Prepare the draft of the thesis report.
7. Thesis examination.

The first formal presentation is in June 2006, and the second formal report is in November 2006.

1.8 Management plan

This section presents my schedule and qualifications for my research. This research will be completed in November 2006. To reach this goal, will follow the schedule that is presented in table 1.7.

Table 1.7: Research schedule

YEAR 2006	JUN	JUL	AUG	SEP	OCT	NOV
1. Study process to produce ice-cream in the line X						
2. Analyze and summarize the previous data to determine the causal relationships among the problem by using WHY-WHY Analysis to know the root cause						
3. Eliminate the problem by using two common methods and trial						
4. Predict the effects on the manufacturing costs by using Cost-Benefit analysis						
5. Select the best solution and Implementation						
6. Evaluate the best solution and Prepare the draft of the thesis report						
7. Thesis examination						

From table 1.7, it can conclude that there are two main methods to achieve thesis's goal that consist of doing quick changeover, and using chemical element. All of these means have to analyse together.

However, the first thing of every part is study involved information and analyse it, and then select the best solution, which helps the company to produce stick product in time like the customers' requirement.

CHAPTER II

LITERATURE SURVEY AND THEORETICAL CONSIDERATION

2.1 Literature Survey

For improvement project, the company should use the most frequent methods to help in different phases. Choosing the suitable methods in the right phase is the most important things. There are several books and articles on these methods.

2.1.1 Problem analysis

The pre-phase, consists of some sort of preparation planning and goal setting so at the beginning of the study, have to understand the process correctly and collect data (Johansson and Grunberg, 2001). Hence, the company will understand where the company position is, and what the actual problem is, which is obstacle of company improvement.

For solving the important problems, the company should use the powerful tools to find the root causes of the problem such as Why-why-why decision. Why-why-why analysis is the easiest method for exploring the root causes of the problem by asking about 4-5 times (McCaffery, Heerey and Bose, 2003; Arkaprathompong, Amonpendkun and Sriprijit, 2004).

However, for applying this methodology effectively, the company should involve all of the involved employees to find the accurate root causes for prevent that problems from recurring (Arkaprathompong, Amonpendkun and Sriprijit, 2004; Management Technologies, Inc., 2003).

Moreover, Why-why-why Analysis also helps the company to plan its action plan, which is not only solve that problem but also prevent the recurrent problem. The why-why analysis process is shown in figure 2.1.

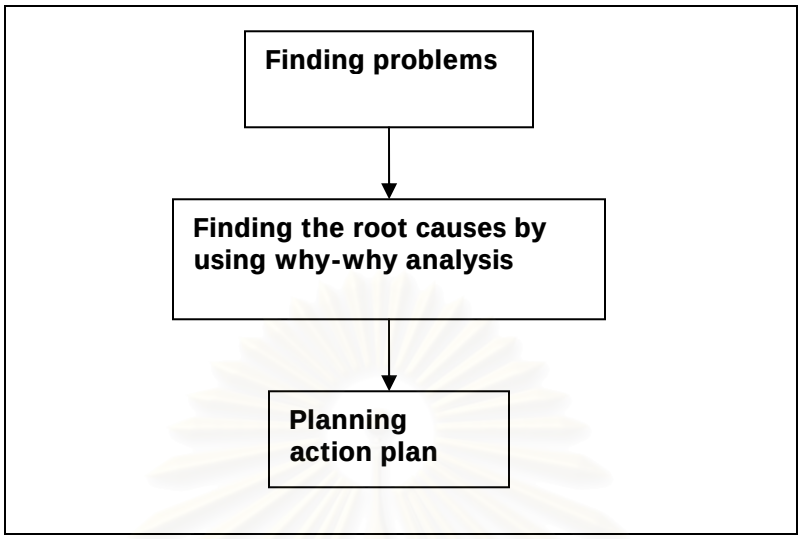


Figure 2.1: Why-why analysis process

2.1.2 Process improvement

Next, after analyzing the problem by using WHY-WHY Analysis to find causes of the problem, has to improve process by using the most frequent methods that are Quick changeover method and Speed up method.

1. Quick Changeover:

Quick Changeover is one of the most effective methods to improve productivity. This methodology is the most important process of setup time reduction by using equipment in shorter time and more simplified form to aid operators and shop floor personnel (Strickland, 1997).

Since this method helps the company to change from one product to another quickly and efficiently, it is suitable for food, beverage and consumer goods businesses that take a long downtime, including cleanup, setup and startup time (Strickland, 1997; IMEC, 2005).

Moreover, this technique is also a critical component of Lean Manufacturing, allowing companies to reduce batch sizes and shorten lead time, making it easier to meet customer demands for high-quality, low-cost products, delivered quickly and without the expense of excess inventory.

For that reason, for getting competitive advantage, the company should use quick changeover technique (IMEC, 2005).

Therefore, this methodology is suitable for the consumable business, because in this business has to change products all the time, and has higher competitive force. Hence, this technique will help the company to get competitive advantage a lot (NWMOC, 2006).

Cleaning system

Cleaning is a careful and essential part in food industry especially in the peak period (Forsythe and Hayes, 1998). Every staff should take some responsibility for ensuring that every using equipment is in high standards of cleanliness and also without of hazards (Blanch, 2003). Cleaning should concern not only by physical- by people - but also by cleaning materials, not be a source of further contamination.

Cleaning process can divide into two types that are cleaning small equipment and large equipment.

- Cleaning small equipment

Cleaning small equipment or easily handled components can be followed by using typical manual procedures or using automatic washing utensil. Automatic washing utensil uses the same basic cleaning sequence, but lack of manual washing.

In typical manual procedures, there are six stages, including of cleaning and disinfection processes, for food-related operation (Blanch, 2003; Forsythe and Hayes, 1998):

1. *Pre-clean*: This stage uses cold water to loose dirt.
2. *Clean*: This stage uses cleaning chemical such as detergent to remove remaining dirt.
3. *Rinse*: This stage uses hot water to remove detergent.
4. *Disinfect*: Disinfecting is used by hot water which is about 82°C to soak about 10 minutes and follow by alkalis-based to soak about 15 minutes. Disinfecting will ensure that micro-organisms are reduced to safe levels. However, not all surfaces and equipment require disinfection stage. It is appropriate for only food and hand contact surfaces.

5. *Dry*: Air drying is the most hygienic method of drying. Drying can reduce micro-organism to multiple, because it can multiple effectively in moist. Therefore, this stage is very important.
6. *Clean and Store cleaning equipment*: All of equipment and chemicals should be store in appropriate areas.

However, for cleaning small equipment more effectively, should select the suitable chemicals to ensure that microbial cannot multiple in the cleaned equipment.

- Cleaning chemicals

There are many chemicals for cleaning small equipment, so the most importance is using the right agent for the right cleaning process. There are two famous chemicals for cleaning small equipment in a food manufacturer that are:

1. Detergent: A detergent is a cleaning agent made of soap or a soap substitute. It is used for remove grease and dirt (Blanch, 2003). Its most important characteristic is softening the hard water. However, there are also a number of types of detergent that are an acid or alkali-based. Hence, for selection will depend on factors such as the mature of the substance to be removed, the material surface of the article to be cleaned (Hobbs and Robert, 2004).

   The general properties for good detergent should be presented in the following (Hobbs and Robert, 2004):

   - The ability to clean wet equipment.
   - The ability to break up and disperse fat.
   - The ability to use in food industry.
   - The ability to soften hard water.
   - Easily rinsed away.
   - Harmlessness.

However, detergent is not suitable for some industries such as crockery, cutlery, and other food containers, because these industries have amount of fat, which detergent cannot clean up (Hobbs and Robert, 2004).

2. Disinfectants: Disinfectants will reduce micro-organisms into an acceptable level by using hot water, which is about 82°C or above, and chemical disinfectants. Thus, the company can ensure that there is no microbial and their spores left behind in its products. The most famous chemicals, which often used by food business, are Hypochlorites compounds such as TOPEX.

- Cleaning large equipment

There are two important methods that are foam cleaning and Cleaning In Place (CIP) system:

1. Foam cleaning

Foam cleaning has become popular especially for cleaning walls, floors, in accessible areas, vehicles and equipment with large food contact surface areas. This foam is not only a cleaner but also a disinfectant to antibacterial or some germs. Therefore, this foam is often a strong acid or alkaline (Hobbs and Roberts, 1993).

For cleaning any agents, this foam is added the detergent formulation, which produces thick foam to cover them. However, to clean more successfully, should left the foam about 10-20 minutes, depending on the particle of dirt (Forsythe and Hayes, 1998).

Since one part of water is equal to 10 parts of foam, foam cleaning can clean more effectively, which is obviously in food factories. For that reason, foam cleaning always uses in food-related manufacturer especially in ice-cream and milk factory, which has an amount of fat.

However, this foam cleaning also has disadvantages that are it has to use a pressure generating system to ensure that the foam remains wet even in the room temperature. Moreover, since they are strong acid and alkaline, employees should not be allowed to touch it directly (Forsythe and Hayes, 1998).

One of the most famous chemicals of foam cleaning is Chloroethyl1- Chloroformate solution, known as SU 616.

- CHLOROETHYL1- CHLOROFORMATE Solution (SU 616)

SU 616 is a strong alkaline, pH 12, which uses for cleaning and sterilizing. Its qualifications are shown in table 2.1.

Table 2.1: SU 616's qualifications

Qualifications	
Characteristic	Liquid
Colour	None
Smell	None
Density	1.03-1.09
Taste	Strong alkaline

SU 616 can use with hot water (more than 82°C), which this qualify is different from other cleaning agents. Furthermore, this solution has small amino, so it can clean fat and protein effectively (Skoog and West, 1980). For that reason, this solution is suitable for using in food and beverage industries, which has amount of fat and protein, and also have to use hot water for cleaning equipment.

In addition, this solution is an effective cleaner not only for food touch equipment but also for wetting agents such as floor and partition, so it will make good working environment.

However, for using SU 616, should mix the solution and water by using solution only 5%-10%, depending on the cleaned particles, in foam injection, shown in figure 2.2. After that, spray foam to cover the cleaned equipment, and then leave it about 15-20 minutes. Finally, rinse it by hot water (Hall, 1989).

Figure 2.2: Foam injection

Nevertheless, since this solution is a strong alkaline, it can wear out some material such as Aluminium and Basses. Consequently, should aware that it can uses only for stainless steel, which has low content of carbon (Skoog and West, 1980).

2. Cleaning In Place (CIP)

Cleaning In Place (CIP) or Sterilization In Place (SIP) is a system designed for automatic cleaning process without assembly and disassembly activities. It is suitable for cleaning tanks, piping and even workplaces. This cleaning process consists of several cycles by recirculating detergent and rinse solution (Optex, 2006).

There are three mainly cleaning steps that are presented in the following (Blanch, 2003):

- In the pre-phase: cleaned by hot water to remove loose dirt.
- In the cleaning phase: cleaned by based solution. When based solution mixes with fat substance, it changes to be an effective detergent to remove remaining dirt. Moreover, its based characteristic also can kill micro-organisms to be in the acceptable level.
- In the final-phase, cleaned by hot water to rinse any remaining disinfectant from the second stage.

Moreover, to do CIP system more effectively, should create powerful flow rates in every phase that are 21-26 gpm (266-283 l/min) by matching of pump velocity and detergent flow (Bete, 2000; Hobbs and Diane, 2004).

However, for doing CIP in tanks, tank is a huge area, and has inlet connection. Thus, its flow rate will be slower, and cannot clean in some areas. For that reason, should use spray nozzle to reach all of internal surfaces, and produce jet of solution (Tank Cleaning technology, 2004). The most useful head should have rinsing diameter of up to 18 ft, and can create slowly rotation and produce large droplets for increased washing impact (Bete, 2000).

Since CIP system avoids of manual procedures especially in hygiene place, the technology of CIP or SIP is obviously necessary for many industries such as food, dairy, beverage, nutraceutical, biotechnology, pharmaceutical, cosmetic, health and personal care industries in which concentrate on aseptic environment (GEA, 2006).

CIP system can reduce manufacturing costs that are not only labour cost and energy cost but also safety costs, because the operator does not allow entering tanks or vessels (Pontemayor, 2000 and Bohn, 1998; GEA, 2006). Moreover, it also can reduce downtime, because product changeover is minimized (GEA, 2006).

Therefore, although, it increases in the price of equipment, it also can save overall costs. Thus, there is no doubt that CIP technique will become more famous in the future in every hygiene industry (Forsythe and Hayes, 1998).

However, all of the cleaning process, including of cleaning small equipment, and large equipment, should do after break immediately or 10-15 minutes later. Since 15 minutes later dirt and fat will stick with the surfaces that microbial will multiple in amounts, and make the cleaning job harder (Blanch, 2003; Forsythe and Hayes, 1998).

Material agents for cleaning equipment

One of the most significant factors to control hygienic in food manufacturer is choosing the right material agents for cleaning equipment (Hobbs and Roberts, 1993). These materials will not be a source of further contamination.

The basic of choosing them is the surfaces should be smooth, hard, continuous and free from pitting, cracks and crevices, where food could collect. Moreover, there is another important factor that is put the right material in the right job (Forsythe and Hayes, 1998; Blanch, 2003).

In food industry should use material, which is resistant of corrosion, smoothly finished, and easily cleanable such as stainless steel and titanium (Forsythe and Hayes, 1998):

- *Stainless steel*: Austenitic Stainless Steels are the most popular used of all surface materials. These steels have high percentages of certain alloying elements but have a very low content of carbon especially in Grade 316. This grade always use in food industry to be material agents and in Cleaning In Place (CIP) system, because it has high corrosion resistance and its smoothly surface finished.
- *Titanium*: Titanium has high quality and very effective material, but its high cost. Thus, it is not use on a large scale. However, it has a greater corrosion resistance than high grade stainless steel, clean easier, and much lighter. Therefore, it always use in food manufacturer but only use on the small scale.

Hazard Analysis Critical Control Point Systems (HACCPs)

Hazard Analysis Critical Control Point Systems (HACCPs) is one of the most important approaches to eliminate the risks of food consumption and food poisoning, and to identify possible areas of risk and minimize or control them. This approach prevents the hazardous problems and their relative risks during production process (Forsythe and Hayes, 1998; Blanch, 2003).

HACCP consists of monitoring and verification procedures, which ensure that the final product will be in an acceptable level. Therefore, in food industry, after the company cleans the equipment, it always do microbiological test to ensure that there is no microbial left behind, which will effect to the end-product (Forsythe and Hayes, 1998; Blanch, 2003).

HACCP in different business has different standard and different type of microbiological test. For example, in ice-cream industry, the company has to check only three types of micro-organism, which can stay in cold stage, that are SPC to be not more that 70 CFU/ml, Colifoam to be 10 CFU/ml or below and E. coli to be not more than 10 CFU/ 25 cm^2 (Forsythe and Hayes, 1998).

2. Speed up:

Freezing is based on two principles (British Nutrition Foundation, 2004):

• Very low temperatures inhibit growth of micro-organisms and stop enzymic and chemical activity
• The formation of ice crystals draws away available water from food, therefore preventing the growth of micro-organisms

In a domestic situation, food is frozen by placing it in a freezer and allowing heat transfer to occur by conduction. This process can take several hours. For that reason, there are other forms of freezing have been developed by the food industry to speed-up the freezing time (British Nutrition Foundation, 2004).

For speed-up the freezing time, there is the most common method, which ensures that products are frozen in the shortest time possible, and reduce the risk of micro-organism growth that is using Liquid nitrogen (British Nutrition Foundation, 2004).

Liquid nitrogen is the most important chemical element to rapid freezing, because it makes not only help ice-cream to freeze in the shorten time but also get rid of microbial, which is the most dangerous hazard of consumable products. Moreover, liquid nitrogen also prevents ice crystal formation throughout product, so the company can get the highest standard products (Phd Mom, 2005).

Liquid nitrogen should fill in the ice-cream mix in the last section that is after mixing the colour/flavour (Phd Mom, 2005). However, liquid nitrogen also has disadvantage that is it can be a hazardous substance, because it can burn in your hand. Therefore, the company should remember this certainly to prevent safety problem.

2.1.3 Select the best solution

The final phase usually consists of evaluation of implementation by concentrating on the standard of the products, such as GMP and HACCP (azimuth, 2006), which are the most important consumable standards, and analysis of the effect on the manufacturing cost to choose the best solution that returns high profits for the company.

Decision making is the cognitive process of selecting a course of action from among multiple alternatives. There are several decision making models for business such as decision trees, and cost-benefit analysis, which is the process of weighing the total expected costs and the total expected benefits (Wikipedia, 2006).

Cost-benefit analysis is the most frequent method for project appraisal to choose the best or most profitable option. Moreover, it also calculates the cost from tangible effects, caused by risk, loss of reputation, market penetration, long-term strategy alignment, etc.. All of them can occur easily in today situation (Wikipedia, 2006).

Moreover, in this methodology, it also includes intangible values too, so it helps the company to estimate the value of intangible benefits (Treasury Board of Canada Secretariat, 1998). Furthermore, this underestimate also calculate a payback period, which tells the time that takes for the benefits of a change to repay its costs. For this reason, the company can sure that decisions you make are successfully implemented (Mindtool, 2006).

For that reason, cost-benefit analysis model is the suitable method for decision marking in today business, because it includes not only financial analysis but also risk analysis too (Wikipedia, 2006). Therefore, the company will make sure that it gets the best solution for its problems.

Moreover, the company has to test the implementation before using it in the real situation and if the test is not like expected, a restart of the improvement will begin (Porras and Robertson, 1992).

2.2 Theoretical Consideration

2.2.1 Gantt chart

Gantt chart, which is usually known as Bar chart or project planning chart, is the simplest and most widely used technique for simple project planning and scheduling. It is a visual model to indicate resource, equipment, employees, and job for a period of time (Clolard and King, 1975).

Gantt chart indicates a number of data, and tells every task lead time. Thus, it uses for a variety of purposes; for instance, the assigning of jobs to machine and the scheduling of jobs in services and manufacturing (Finch and Luebbe, 1984). Moreover, because of the data from Gantt chart, the company can calculate the actual budget and resource utilization, comparing with the planned utilization more correctly (Randolph and Posner, 1988).

The chart consists of a horizontal scale, which tells about time unit, and a vertical scale, showing project work elements such as tasks, activities, work, and resources. The start and end of each task is indicated by the beginning and the ending of each bar (Nicholas, 1990).

There are a number of advantages of using Gantt chart, which are shown in the following:

- The primary advantage: Since this chart is a visual model, every involved staff can understand easily (Nicrolas, 1990; Slack, Chambers and Johnston, 1995; Rando;ph and Posner, 1988).
- The plan, schedule and progress of the project can draw in the same graph, so it is very helpful for analyse (Clelard and King, 1975).
- It is a useful overview of project, because it can show the entire of project. Moreover, it is also an important tool for monitoring project progress (Rondolph and Posner, 1988), which effects to motivate project team (Nicrolas, 1990).
- It is a useful technique for communicating project plans not only for project managers but also for senior managers and day-to-day staffs (Slack, Chambers and Johnston, 1995).

From its above advantages, it can conclude that this chart is the most powerful technique to plan and control project. Moreover, it is also the most useful tool to calculate the optimize budget and resource utilization for each task.

However, it also has limited, because it can tell an amount of information. Thus, it cannot display for large or complex project, because it will show complicated data, which cannot identify the best schedule and optimize information (Finch and Luebbe, 1984; Nicholas, 1990; Slack, Chambers and Johnston, 1995).

2.2.2 Flow process chart

Flow process chart (also spelled as flowchart or flow-chart) is one of the most essential business charts to record and summary overall manufacturing data. It studies product flow through a manufacturing process. This chart can indicate not only the activities of a product but also a man, depending on the situation (Moore, 1970). Thus, it is no doubt that every company always uses this chart for analysis.

The heading of the chart shows what aspect of the operation that are analyzing and where the process begins and ends. After that, list the steps that are involved in the process in the sequence. Next draw a line to connect the symbols, which identify each step activity (Tompkins, White, Bozer and Tanchoco, 2003).

In flow process chart, it indicates all of activities that are operations, transportations, inspection, delays and storages during process by using ANSI standard symbols (American National Standards Institute's standard symbols), shown in Table 2.2 (Wadsworth, Stephens and Godfrey, 1986).

Table 2.2: ANSI standard symbols

Symbol	Name	Meaning
	Operation	An action or process
	Transport	Movement of people or things.
	Delay	Idle time of people or machines.
	Storage	Longer-term storage of materials or other items.
	Inspection	Checking of items to ensure correct quality or quantity

Therefore, this chart can identify which activity during operation process should be improved.For that reason, it is no doubt that this chart always uses for developing procedures to be more effectively (Tompkins, White, Bozer and Tanchoco, 2003).

2.2.3 Pareto chart

The Pareto chart is one of the most important engineering charts especially for process improvement, because it looks simple and can understand easily from its visual format. In this chart, there are three sides of the chart that are X axes, which shows the data, and two Y axes, which show the frequency and percentage.

In the left side of the Y axis, it looks basically like bar chart. It shows the frequencies of occurrences. Thus, this side always uses for finding causes of problems, and also determines which cause is the most frequency.

In the other side of the Y axis, it has line graph to tell the cumulative percentage of occurrences. Hence, this side will tell the percentage of each cause, which help to solve the problem and improve process by using 80/20 rule. This rule indicates that 20% of all causes that effect to

problem above 80% should be eliminated first, because they are the main obstacles (Andersen and Fagerhaug, 1999; Gehani 1998).

There are four steps to construct Pareto chart, shown in the following (Madison, 1988; Gehani 1998):

Step 1: Identify problem and collect raw data.
Step 2: Order data from the largest number to smallest one.
Step 3: Put the ordered data into the bar chart for the left side of Y axis. However, should ensure that the width of each category is equal.
Step 4: Translate the raw data to the cumulative percentages, and put them in to the right hand side. The maximum of the cumulative percentages should be 100%.

However, Pareto chart is only the visual chart to show the most frequency and the most serious causes of the problem. As a result, for solving problem more effectively, should use Pareto chart combining with other process improvement techniques (Madison, 1988).

2.2.4 ECRS technique

ECRS technique helps the company to improve present procedure by reducing an amount of wastes, costs and time. Moreover, it is also one of the most popular tools to solve industrial problems, which will effect to increase productivity, improve equipment and human utilization, and advance organizational goals (Barnes, 1980). ECRS method is stand for E-Eliminate, C-Combine, R-Rearrange, and S-Simplify technique, which will explain in the following:

- *E- Eliminate*: To eliminate unnecessary jobs and bottleneck activity- Unnecessary jobs such as repetitive tasks and complicated jobs, and bottleneck activity cause not only an amount of time waste but also huge costs (Gillespie, 1952). Therefore, to increase efficiency work, should eliminate all of these unnecessary jobs.
- *C- Combine*: To combine similar jobs to be one work- Doing each activity should lose an amount of time and costs for preparation. Therefore, combination method has become to be known widely. It combines similar activities to do in the same time. This method is not only reduce waste time but also improve existing procedure especially in manual

system. Therefore, it can conclude that this method help the company to be more cost-effectiveness by getting rid of repetitive tasks (Dekkert, Smit and Losekoot, 1991).

- *R- Rearrange*: To rearrange the present job to be more effective scheduling- The effective scheduling is every involved staff can do their jobs in parallel, which is no fragment by using resource-allocation (Zhou, Mackerras, Johnson, Walsh and Brent, 1999), and also consider about the relationship between two activities that are before and after activities to be no interaction (Leondes, 2003).

  Therefore, this method will bring the efficiency system of resource utilization, and also improve the production system and job performance (Zhou, Mackerras, Johnson, Walsh and Brent, 1999). For that reason, it will help the company to get competitive advantage, and achieve its goal more easily.
- *S- Simplify*: To simplify difficult and complicated jobs by using some equipment or automatic system- The complicated and difficult jobs need high skilled workers, and also take a long time to do. Therefore, the company should spend an amount of employees' cost and processing time, so doing simplify method will be not only help the company to gain higher profit but also reduce manufacturing costs (Leondes, 2003).

Therefore, it can conclude that ECRS technique helps the company to reduce an amount of waste time and costs by unnecessary tasks elimination. For that reason, it is no doubt that ECRS method is one of the well- known techniques for improvement process and activities. Moreover, from its result, it also helps the company to gain competitive advantage and higher profit.

2.2.5. Why-Why analysis

Why-Why analysis, known as 5 why's analysis, is one of the most important techniques to find root cause. It was used in the first time in the early 1950s by Toyota Company to find the root causes of quality problems. Nowadays, it uses widely in many industries to find the root causes of serious problems, which occurs frequently (Straker, 1995; Arkaprathompong, Amonpendkun and Sriprijit, 2004). Besides, it always innovates or generates new idea to get the best process.

To analyse by using Why-Why analysis should repeat to ask Why? Question in each stage until finding the root causes, normally asking about 5 times. In each stage, there can be the multiple answers for answering the question, because one problem can come from many reasons.

There are four principle stages, shown in the following (Straker, 1995):

1. Put the problem in the left side.
2. Generate the idea to know the main causes into the right side.
3. Repeat the sequence by breaking down the main causes to be the problem, and asking Why question “Why does this happen?” to know the root causes of each main causes.
4. Keep asking Why Question until finding the root causes. After finding the root causes, generate idea to solve the problem.
5. Then, will get the optimize solution to solve the root causes, which will help to eliminate problem from the process.

However, for doing why-why analysis more effectively, should let the involved employees who face the problem directly to do it, because they will know what the problem comes from exactly. For that reason, it can ensure that can eliminate the problem definitely. On the other hand, why-why analysis also has the limited that is it can analyse only the confined problem, which one by one method. (Burke and Ireland, 2005).

CHAPTER III

METHODOLOGY

To do process improvement project, the methodology should involve all of the effective techniques and tools to get the optimize results, which are not only improve process and activities but also spend cost and use resource utilization more effective.

The methodology, which is used in this thesis, consists of seven steps, shown in figure 3.1:

1. Study the current process
2. Identify problem activities
3. Develop improvement plan
4. Make a study of economic evaluation
5. Test the improvement in the actual process
6. Make a study of technical evaluation
7. Implement in the actual process

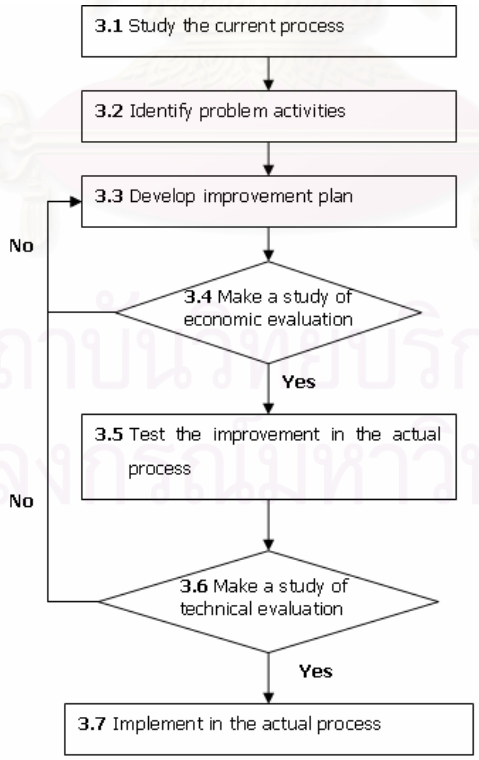


Figure 3.1: Overview Methodology Flow

The detail of each step is shown in the following:

3.1 Study the current process

Observation of the existing process is one of the most important things for understanding process flow and problems. The scope in this thesis consists of two departs that are cleaning process and speed up process.

- **Method of information collection**

Information collection is the most important first step for development process, because the collected data has to be analysed in the further stages. For that reason, collecting raw data must be careful to get the actual and correct data.

In this thesis, there are two points, so there are two different ways to collect data, presented in the following:

1. **Collect the existing changeover process**

Most of data to be collected in this process are working activities and lead time in each task, so the most effective way to collect them is record without employees notice. Thus, the collected data will be the actual ones.

Moreover, for observation to be more efficiency, should use some equipment to help such as camera or video tape, which can record and observe every worker especially in the parallel time.

As a result, there are two ways to collect data in this process, presented in the following:

1. Observation and catch up the time by naked eye.
2. Using camera or video tape to record every worker's activities, and take the picture of problems during operation process.

2. Collect freezing process

Freezing process is the most important factor to get competitive advantage especially in the ice-cream industry, because it spends an amount of production time. The data to be collected in this project is how to freeze the mixed ice-cream, and a freezing time to get the specific ice-cream.

There are three steps to get the correct data that are presented in the following:

1. Since freezing process is an automatic system, should collect the data from the machine manual.
2. Interview and questioning the involved staff to ensure that the collected data from the manual match to the existing process.
3. Observation and catch up the freezing time.

Information collection aims to:

1. To analyse process flow.
2. To determine problems during operation process.
3. To identify activities, which should be improved in the proposed process.

3.2 Identify problem activities

To identify problem activities, should analyse the existing processes that are changeover process and speed up process. The analysis will know which activities take a long time and how many losses from those activities. After that, find the root causes of each problem by using why-why analysis for eliminating the problem definitely.

3.3 Develop improvement plan

This step should eliminate the root causes by using process improvement techniques. In this thesis, choose to use ECRS techniques, which will improve working activities and apply some automatic equipment.

However, the results after analysis should be approved by the meeting, which will match the analysis to the budget and to the actual process. This meeting participates all of the involved staffs such as manager to approve the budget, and supervisors and operators to make sure that these solutions can use in the actual process.

3.4 Make a study of economic evaluation

After ensure that the solutions can apply in the real situation, has to do the economic evaluate to ensure that the solutions of each project are profitable and worth to investment. For doing economic evaluation, choose to analyse by using cost-benefit analysis, which is not only calculate financial analysis but also risk analysis. For that reason, will get the optimize solutions, which return high profits for the company.

From the analysis, can get two different results, presented in the following:

1. If the result is yes, it means this project is worth to invest. Thus, can do the next stage.
2. If the result is no, it means this project is not worth to invest. Hence, should go back to the previous stage to develop the new improvement plan. After that, go to this stage in the next time, and recirculate it until getting the yes answer.

3.5 Test the improvement in the actual process

If the results in the economic evaluation are yes, should test those solutions in the real situation. The main reasons in this stage are ensuring that these solutions can use in the real situation, and generate the best result, including of time and resource utilization. Moreover, to make sure that they will not bring other problems, which also effect to manufacturing costs and performance, to these processes again.

3.6 Make a study of technical evaluation

Although since this thesis concentrates on food-related industry, economic evaluation and testing improved processes are not enough. It has to worry about HACCP concept, which concern about

food poisoning. The company has to measure quantity of microbial in food during operation process to be in the standards.

These standards effect to business straightly, because it is also the legal standard. Thus, if the company's products have microbial more than standard, it cannot sell product in the market. For that reason, if the solutions do not pass this technical evaluation, should go back to the development stage again to create the new technique.

As a result, for process improvement in this food industry, should consider not only about process improvement but also hygiene in the same time.

3.7 Implement in the actual process

After pass every testing and evaluation process, can guarantee that these solutions are the optimize solutions. They are not only improving process to be more effective but also return high profits for the company. Consequently, do not hesitate implement all of the optimize solutions in the actual situation.

CHAPTER IV

COMPANY PROFILE AND ANALYSIS

4.1 Company Background

ABC Ice-Cream is one of the leading ice-cream manufacturer companies, started in 1989. It was located at Min Buri (Lardkarbang industrial park), which has 45,000 m^2 areas. The markets of the company's product are both local and export markets.

4.1.1 Company products

It has 9 production lines to produce about 118 types of products for domestic and overseas consumptions. There are two basic types of ice-cream, which are icy ice-cream, which is only 5% of all products and milky ice-cream, which is about 95% of all products. Moreover, all of them also can divide into three patterns that are stick, cone, and cup, shown in figure 4.1.

Figure 4.1: Company product

Since the company's main market is children, the company has to study about children's behaviour to support the right product. From market research, it can conclude that main customer prefers sticky and cup ice-creams, because they love to collect ice-cream stick, and easy to consume. Hence, the company produces this pattern more than the others, shown in figure 4.2.

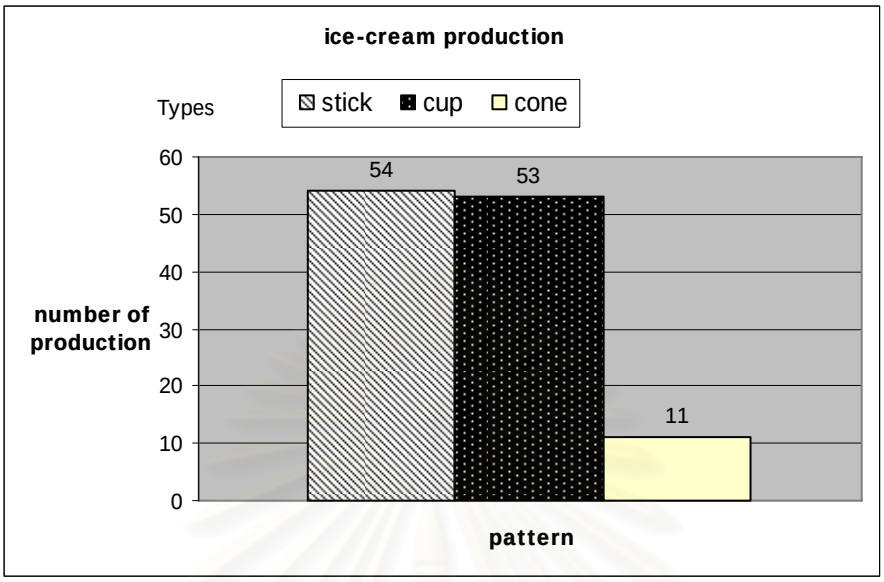


Figure 4.2: Ice-cream production

Therefore, for getting competitive advantage, the company has to produce children's required products faster especially in the peak periods. Since its main market is children, its peak periods is not only in the summer like the other cold beverages' business but also when the school closed term too. For that reason, there are two peak periodss that are in April and October.

4.1.2 Organisation chart

The company has two main departments that are administration and factory departments. In administration department, consists of marketing, and finance. In factory department, includes of packing that is responsible for ice-cream production, logistic, store and research & development that are supported departments, shown in figure 4.3.

The business processes of the company starts at the administration department to receive customer orders and send them to the factory department to produce products and send them to the customers.

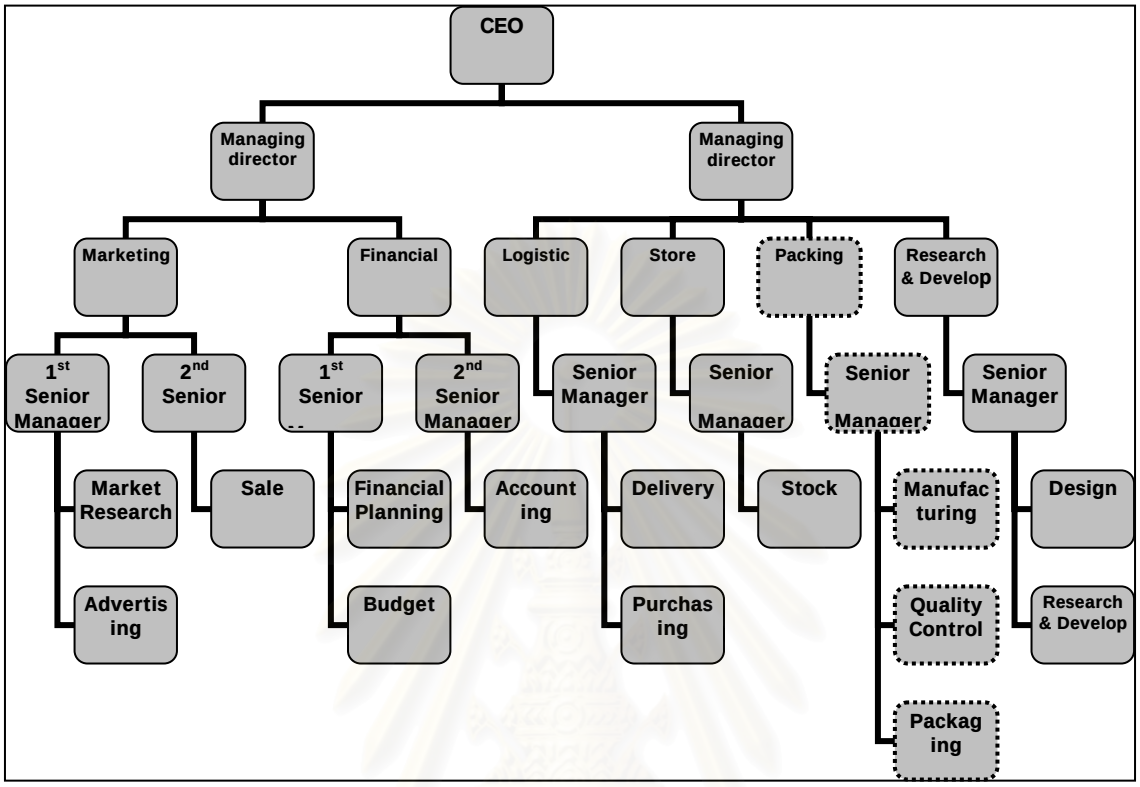


Figure 4.3: Organisation chart

Since packing function is responsible for forming and packaging processes, this thesis involves in this function. In packing department, there are about 9 production lines, which consist of 5 lines for cup ice-cream production, 3 lines for stick ice-cream production, and 1 line for corn ice-cream production.

In this department, there are a senior manager of each department for controlling his department's performance to achieve overall company's objective, five supervisors for controlling workers' job to achieve to manager's objectives, and workers.

4.2 Existing system analysis

Sine customers' satisfaction is one of the most important factors to get competitive advantage, the critical current problem is unsupportable product. From why-why analysis, it can conclude that the roots cause of this problem come from taking a long time in cleaning and freezing times.

Moreover, all of the stick lines use the same machines, so for solving effectively, should solve the most serious problem, because if solve the most serious line, the others will be solved too. Hence, in this research, concentrates on only the most serious line that is line X.

4.2.1 Long set up time

In Line X, there are seven machine parts, shown in figure 4.4.

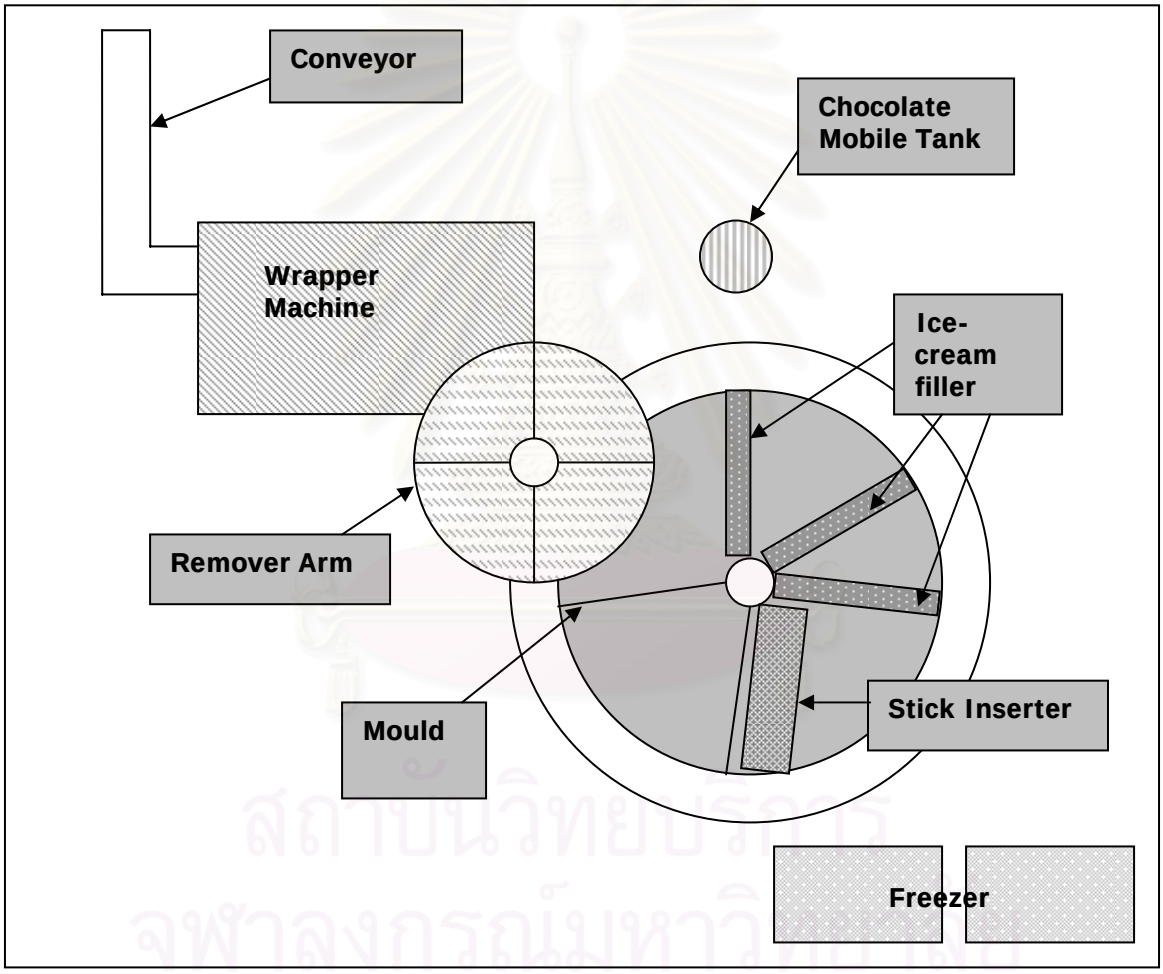


Figure 4.4: stick machine

However, if produces product, which does not be covered by chocolate, do not use chocolate mobile tank. Thus, it can conclude that there are two patterns in 25 products that are original and mixed chocolate patterns, shown in figure 4.5 and 4.6.

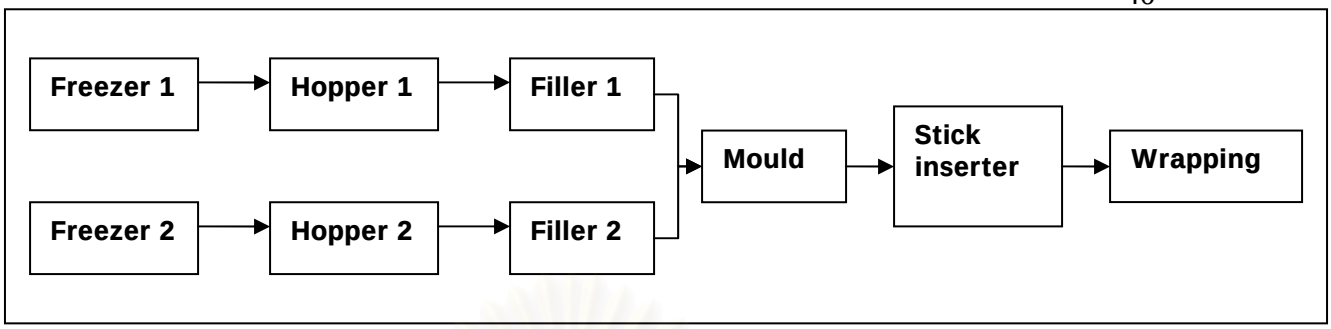


Figure 4.5: Forming and packaging processes of original pattern

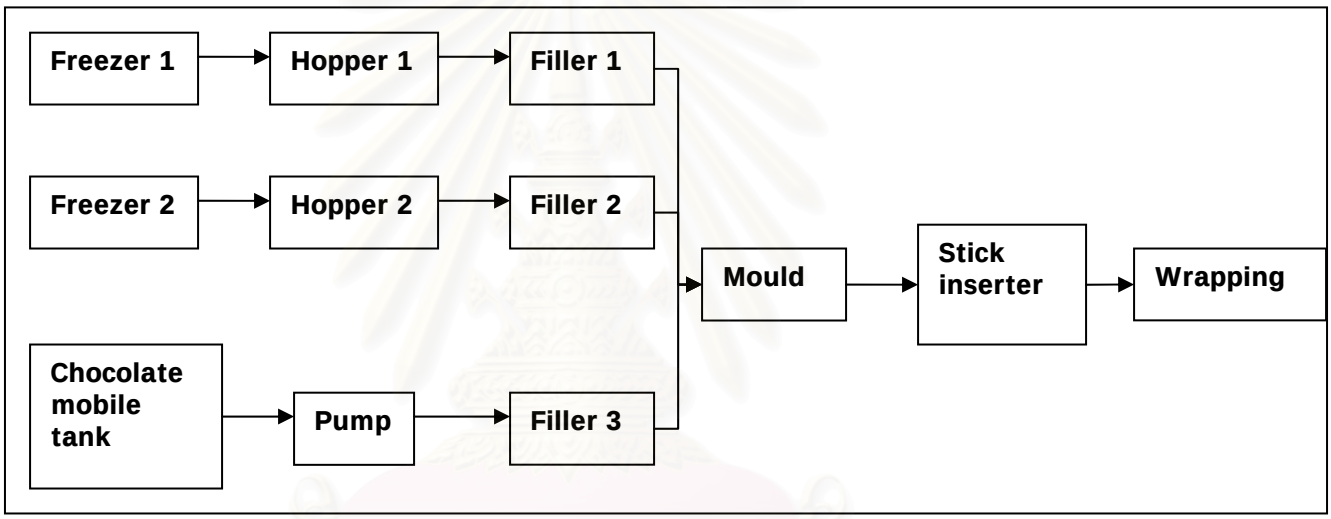


Figure 4.6: Forming and packaging processes of mixed chocolate pattern

Therefore, there are six types of cleaning processes that are two cleaning process when using machine about 90 minutes that are in original pattern and in mixed chocolate pattern, and four changing processes that are changing from original pattern to original pattern, from original pattern to mixed chocolate pattern, from mixed chocolate pattern to original pattern, and mixed chocolate pattern to mixed chocolate pattern.

However, changing from original pattern to mixed chocolate pattern and changing from mixed chocolate pattern to original pattern are the same process, so consider on only one process. Hence, to get the best procedures, which use the reasonable time, should consider on each cleaning procedures to know current processes about how long cleaning process takes, and which the longest task is, shown in Gantt chart in figure 4.7 - 4.11.

Figure 4.7: Gantt chart of cleaning process

when using machine 90 minutes in original pattern (before implementation) [5.28 Hrs.]

ID	part	Task Name	Resource Names	Duration	Pre
1	freezer	cleaning	operator	10 mins	
2	filler & hopper	remove filler	operator	38 mins	1
3		cleaning	A&B	32 mins	2
4		keep old filler	D&E	82 mins	2
5		boiling	A,B&D	45 mins	4
6		soaked by TOPEX	A,B&D	45 mins	5
7		assembly	A,B,C&D	45 mins	6
8	mould	clean the old mixed	acdct	80 mins	2
9		clean on machine	acdct& C	88 mins	8
10		boiling	acdct	42 mins	9
11		remove boiled water	acdct	80 mins	10
12		soaked by TOPEX	acdct	46 mins	11
13		remove TOPEX	acdct	30 mins	12
14	arm and wrapper	cleaning	C	30 mins	1
15	conveyor	cleaning	C	10 mins	14
16	stick	cleaning	E	40 mins	8
17	swap test		operator	8 mins	13
18	set up		operator	5 mins	17

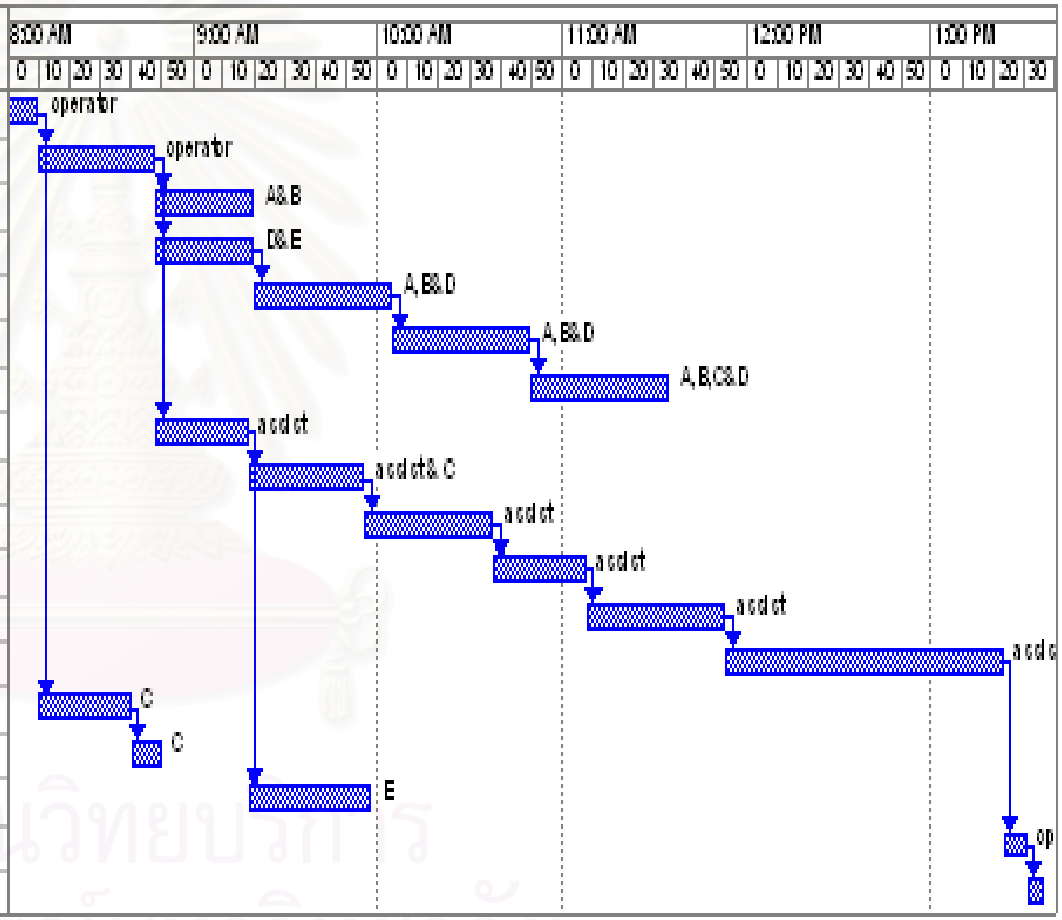


Figure 4.8: Gantt chart of cleaning process

when using machine 90 minutes in mixed chocolate pattern (before implementation) [6.07 Hrs.]

ID	part	Task Name	Resource Names	Duration	Pre
1	freezer	cleaning	operator	10 mins	
2	filler & hopper	remove filler	operator	38 mins	1
3		cleaning	A&B	32 mins	2
4		keep old filler	D&E	32 mins	2
5		boiling	A,B&D	45 mins	4
6		soaked by TOPEX	A,B,D&E	45 mins	5
7		assembly	A,B,C,D&E	45 mins	6
8	mould	clean the old mixed	accict	30 mins	2
9		clean on machine	accict&C	38 mins	8
10		boiling	accict	42 mins	9
11		remove boiled water	accict	30 mins	10
12		soaked by TOPEX	accict	46 mins	11
13		remove TOPEX	accict	30 mins	12
14	tank	remove the old mix	C	45 min	1
15		clean	operator	60 min	14
16		soaked by boiled water	operator	70 min	15
17		soaked by TOPEX	operator	95 min	16
18		assemble	operator	20 min	17
19	arm and wrapper	cleaning	C	30 mins	14
20	conveyor	cleaning	C	10 mins	9
21	stick	cleaning	E	40 mins	8
22	swap test		operator	8 mins	18
23	set up		operator	5 mins	22

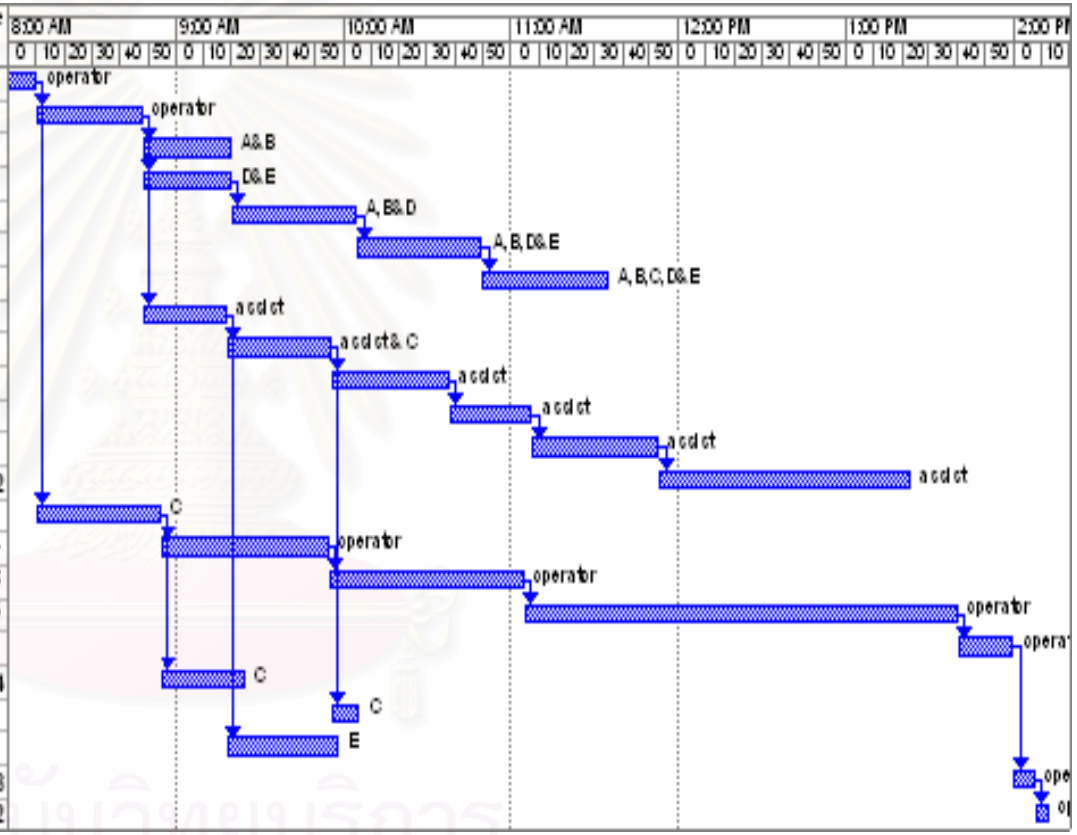


Figure 4.9: Gantt chart of cleaning process

when changing product from original pattern to original pattern (before implementation) [7.00 Hrs.]

ID	part	Task Name	Resource Names	Duration	Pre
1	freezer	cleaning	operator	10 mins	
2	filler	remove filler	operassist	38 mins	1
3		cleaning	A&B	32 mins	9
4		keep old mixed	A&B	32 mins	3
5		boiling	A&B	90 mins	4
6		soaked by TOPEX	A,B&D	45 mins	5
7		assembly	A,B,C&D	45 mins	6
8	mould	clean on machine	C	38 mins	1
9		remove	operassist,D&E	58 mins	2
10		seal mould	operassist,D&E	65 mins	9
11		clean sealed mould on machine	assist&C	30 mins	10
12		boiling	assis	42 mins	11
13		remove boiled water	assis	30 mins	12
14		soaked by TOPEX	assis	45 mins	13
15		remove TOPEX	assis	30 mins	14
16	arm and wrapper	cleaning	C	30 mins	8
17	conveyor	cleaning	C	10 mins	16
18	stick	cleaning	C	40 mins	17
19	swap test		operator	10 mins	15
20	set up		operator	5 mins	19

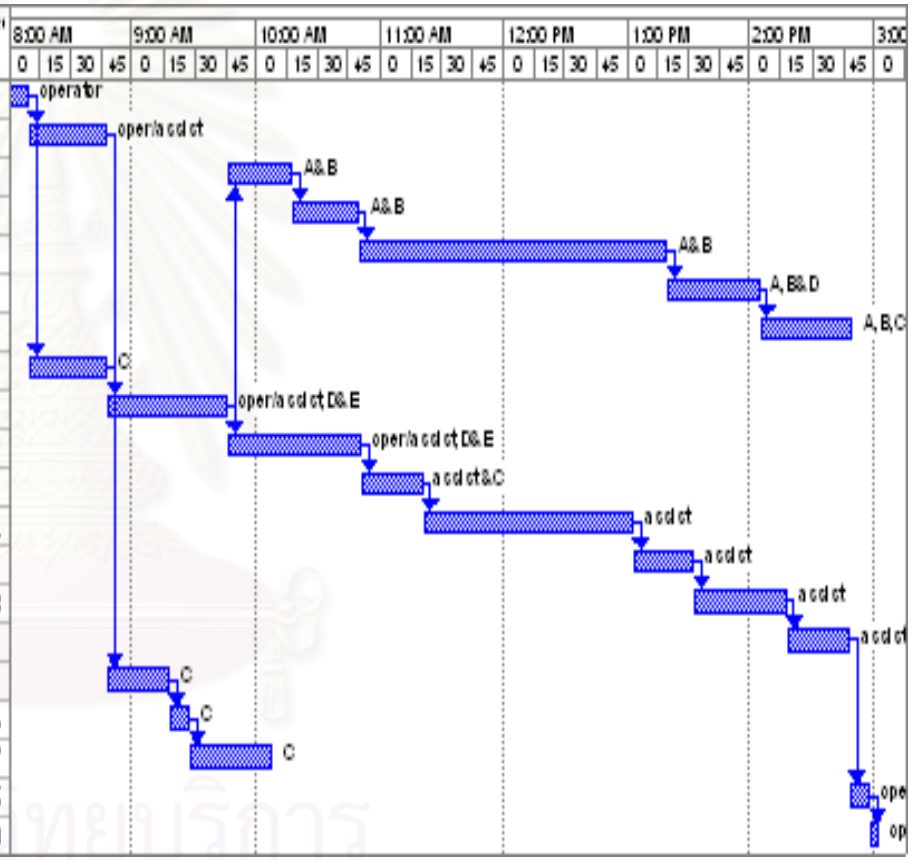
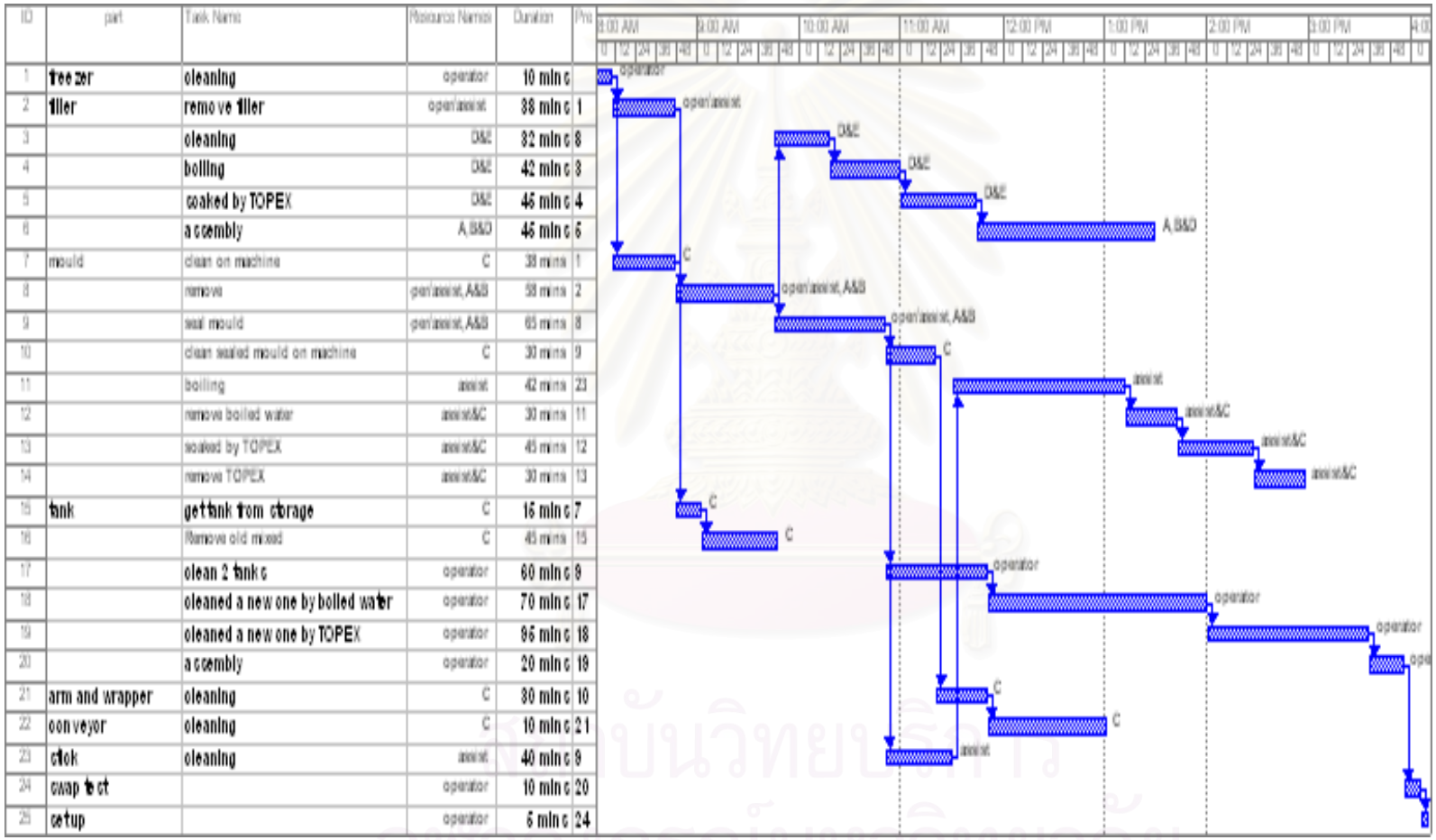


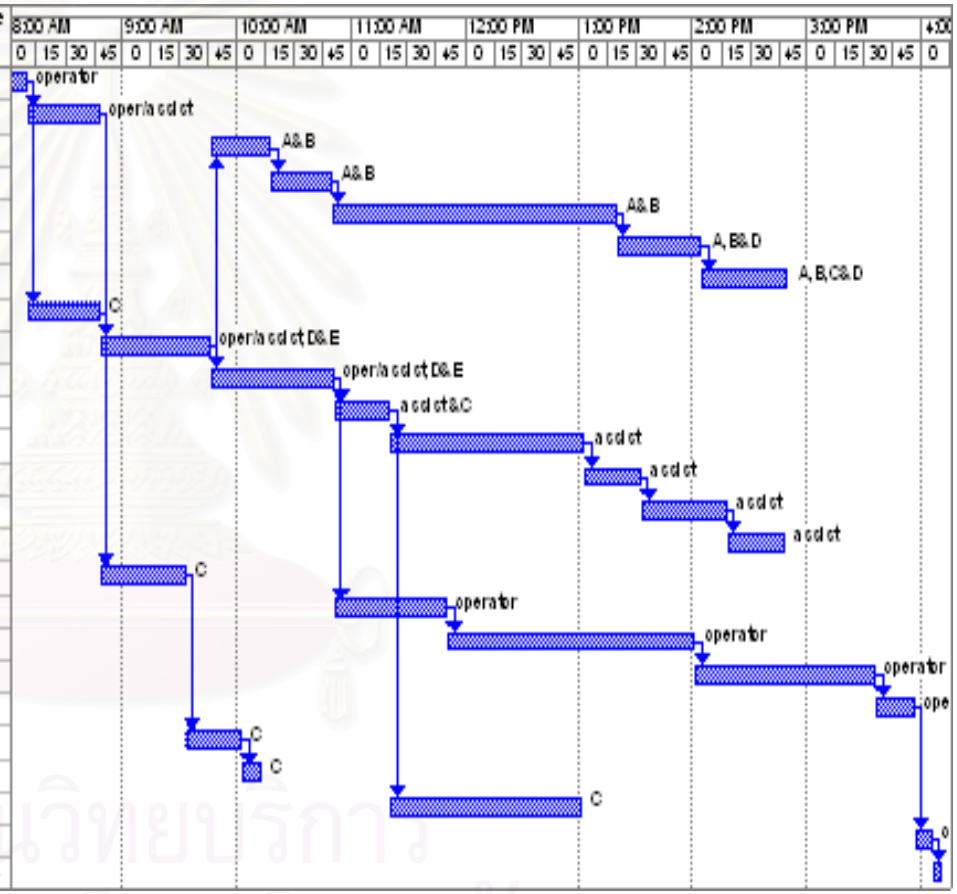
Figure 4.10: Gantt chart of cleaning process when changing product from original pattern to mixed chocolate pattern (before implementation) [8.06 Hrs.]



ID	part	Task Name	Resource Names	Duration	Pre
1	freezer	cleaning	operator	10 mins	
2	filler	remove filler	operi assist	88 mins	1
3		cleaning	D&E	82 mins	8
4		boiling	D&E	42 mins	3
5		soaked by TOPEX	D&E	46 mins	4
6		assembly	A,B&D	46 mins	5
7	mould	clean on machine	C	38 mins	1
8		remove	operi assist, A&B	58 mins	2
9		seal mould	operi assist, A&B	65 mins	8
10		clean sealed mould on machine	C	30 mins	9
11		boiling	assist	42 mins	23
12		remove boiled water	assist&C	30 mins	11
13		soaked by TOPEX	assist&C	45 mins	12
14		remove TOPEX	assist&C	30 mins	13
15	tank	get tank from storage	C	16 mins	7
16		Remove old mixed	C	45 mins	15
17		clean 2 tanks	operator	60 mins	9
18		cleaned a new one by boiled water	operator	70 mins	17
19		cleaned a new one by TOPEX	operator	95 mins	18
20		assembly	operator	20 mins	19
21	arm and wrapper	cleaning	C	80 mins	10
22	conveyor	cleaning	C	10 mins	21
23	clok	cleaning	assist	40 mins	9
24	swap test		operator	10 mins	20
25	setup		operator	5 mins	24

Figure 4.11: Gantt chart of cleaning process when changing product from mixed chocolate pattern to mixed chocolate pattern (before implementation) [8.07 Hrs.]

ID	part	Task Name	Resource Names	Duration	Pre
1	freezer	cleaning	operator	10 mins	
2	filler	remove filler	oper/assis	38 mins	1
3		cleaning	A&B	32 mins	9
4		keep old mixed	A&B	32 mins	3
5		boiling	A&B	90 mins	4
6		soaked by TOPEX	A,B&D	45 mins	5
7		assembly	A,B,C&D	45 mins	6
8	mould	clean on machine	C	38 mins	1
9		remove	oper/assis I,D&	58 mins	2
10		seal mould	oper/assis I,D&	65 mins	9
11		clean sealed mould on machine	assis I &(	30 mins	10
12		boiling	assis	42 mins	11
13		remove boiled water	assis	30 mins	12
14		soaked by TOPEX	assis	45 mins	13
15		remove TOPEX	assis	30 mins	14
16	tank	remove the old mix	C	45 mins	8
17		clean	operator	60 mins	10
18		soaked by boiled water	operator	70 mins	17
19		soaked by TOPEX	operator	95 mins	18
20		assemble	operator	20 mins	19
21	arm and wrapper	cleaning	C	30 mins	16
22	conveyor	cleaning	C	10 mins	21
23	stick	cleaning	C	40 mins	11
24	swap test		operator	10 mins	20
25	set up		operator	5 mins	24



From figure 4.7-4.11, it can conclude that the changing products take very long time in every changing process that is more than 5 hours. The main reasons are the cleaning of chocolate mobile tank, and mould. Thus, should reduce time from cleaning chocolate mobile tank and mould.

Moreover, should consider on the flow of process to get the best procedures, including the least number of waiting and transportation processes, shown in flow process chart in table 4.1 – 4.5.

Table 4.1: Flow process chart of cleaning process when using machine 90 minutes in original pattern (before implementation)

Flow Process Chart								
Activity: Cleaing process when using machine 90 minutes in original pattern (before implementation)			Summary					
			Activity				Numbers of steps	
			Operation				16	
			Transporation				8	
			Delay				3	
			Inspection				0	
			Store				0	
Describe	QYT (People)	Time (Mins)	Symbol					
Operator								
1.cleaning freezer	1	10						
2.remove filler	1	38						
3. go to get the next raw material	1	10						
4. waiting for the next raw material	1	15						
5. receive the next raw material	1	10						
6. move to the machine	1	10						
Assistant								
1. cleaning old mixed in mould	1	30						
2. cleaning mould on machine	1	38						
3. move to get vacuum tube	1	15						
4. move to get boiling water	1	5						
5. boiling mould	1	42						
6. removing boiled water	1	30						
7. move to get TOPEX	1	5						
8. soaking by TOPEX	1	46						
9. removing TOPEX	1	30						
Workers 1,2,3 & 4								
1.cleaning mould on machine	1	38						
2.cleaning filler & hopper	2	32						
3. move old filler to storage	2	32						
4. move equipment to the boiler	3	10						
5. setting the boiler	1	10						
6. waiting for boiling	3	45						
7. move the equipment to soak TOPEX	3	15						
8. waiting for soaking TOPEX	3	45						
9. cleaning stick inserter	1	40						
10. cleaning arm and wrapper	1	30						
11. cleaning conveyor	1	10						
12.assembly filler	4	45						

Table 4.2: Flow process chart of cleaning process when using machine 90 minutes in mixed chocolate pattern (before implementation)

Flow Process Chart								
Activity: Cleaing process when using machine 90 minutes in mixed chocolate pattern (before implementation)			Summary					
			Activity				Numbers of steps	
			Operation				19	
			Transporation				8	
			Delay				4	
			Inspection				0	
			Store				0	
Describe	QYT (People)	Time (Mins)	Symbol					
Operator								
1.cleaning freezer	1	10						
2.remove filler	1	38						
3. go to get the next raw material	1	10						
4. waiting for the next raw material	1	15						
5. receive the next raw material	1	10						
6. move to the machine	1	10						
7.waiting for cleaning tank	1	10						
8. cleaning tank	1	225						
9. assembly of tank	1	20						
Assistant								
1. cleaning old mixed in mould	1	30						
2. cleaning mould on machine	1	38						
3. move to get vacuum tube	1	15						
4. move to get boiling water	1	5						
5. boiling mould	1	42						
6. removing boiled water	1	30						
7. move to get TOPEX	1	5						
8. soaking by TOPEX	1	46						
9. removing TOPEX	1	30						
Workers 1,2,3 & 4								
1. removing the old mixed in tank	1	45						
2.cleaning mould on machine	1	38						
3.cleaning filler & hopper	2	32						
4. move old filler to storage	2	32						
5. move equipment to the boiler	3	10						
6. setting the boiler	1	10						
7. waiting for boiling	3	45						
8. move the equipment to soak TOPEX	4	15						
9. waiting for soaking TOPEX	4	45						
10. cleaning stick inserter	1	40						
11. cleaning arm and wrapper	1	30						
12. cleaning conveyor	1	10						
13.assembly filler	5	45						

Table 4.3: Flow process chart of cleaning process when changing product from original pattern to original pattern (before implementation)

Flow Process Chart								
Activity: Changing from original pattern to original pattern (before implementation)			Summary					
			Activity			Numbers of steps		
			Operation			24		
			Transporation			7		
			Delay			4		
			Inspection			0		
			Store			0		
Describe	QYT (People)	Time (Mins)	Symbol					
Operator								
1.cleaning freezer	1	10						
2.remove filler & hopper	1	38						
3.waiting for remove mould	1	3						
4.remove mould	1	58						
5. go to get the next raw material	1	10						
6. waiting for the next raw material	1	15						
7. receive the next raw material	1	10						
8. move to the machine	1	10						
9.seal mould	1	65						
Assistant								
1. cleaning old mixed in mould	1	30						
2. cleaning mould on machine	1	38						
3.remove mould	1	58						
4.seal mould	1	65						
5. cleaning seal mould	1	30						
3. move to get vacuum tube	1	15						
4. move to get boiling water	1	5						
5. boiling mould	1	42						
6. removing boiled water	1	30						
7. move to get TOPEX	1	5						
8. soaking by TOPEX	1	46						
9. removing TOPEX	1	30						
Workers 1,2,3 & 4								
1.cleaning mould on machine	1	38						
2.remove mould	2	58						
3.seal mould	2	65						
4. cleaning seal mould	1	30						
5.cleaning filler & hopper	2	32						
6. move equipment to the boiler	2	10						
7. setting the boiler	1	10						
8. waiting for boiling equipment	2	90						
9. move the equipment to soak TOPEX	3	15						
10. waiting for soaking TOPEX	3	45						
11. cleaning stick inserter	1	40						
12. cleaning arm and wrapper	1	30						
13. cleaning conveyor	1	10						
14.assembly filler	4	45						

Table 4.4: Flow process chart of cleaning process when changing product from original pattern to mixed chocolate pattern (before implementation)

Flow Process Chart								
Activity: Changing from original pattern to mixed chocolate pattern (before implementation)			Summary					
			Activity		Numbers of steps			
			Operation	○	27			
			Transporation	⇨	7			
			Delay	D	5			
			Inspection	□	0			
			Store	▽	0			
Describe	QYT (People)	Time (Mins)	Symbol ○	⇨	D	□	▽	
Operator								
1.cleaning freezer	1	10						
2.remove filler	1	38						
3.waiting for remove mould	1	5						
4.remove mould	1	58						
5.seal mould	1	65						
6. go to get the next raw material	1	10						
7. waiting for the next raw material	1	15						
8. receive the next raw material	1	10						
9. move to the machine	1	10						
10.waiting for cleaning tank	1	10						
11. cleaning tank	1	225						
12. assembly of tank	1	20						
Assistant								
1. remove filler	1	38						
2.remove mould	1	58						
3.seal mould	1	65						
4 move to get vacuum tube	1	15						
5. move to get boiling water	1	5						
6. boiling mould	1	42						
7. removing boiled water	1	30						
8. move to get TOPEX	1	5						
9. soaking by TOPEX	1	46						
10. removing TOPEX	1	30						
11. cleaning stick inserter	1	40						
Workers 1, 2, 3 & 4								
1.go to get tank from storage	1	15						
2. remove old mixed in tank	1	45						
3.cleaning mould on machine	1	38						
4.remove mould	2	58						
5.seal mould	2	65						
6. cleaning seal mould	1	30						
7. removing boiled water in mould	1	30						
8. move to get TOPEX in mould	1	5						
9. soaking by TOPEX in mould	1	46						
10. removing TOPEX in mould	1	30						
11.cleaning filler & hopper	2	32						
12. move equipment to the boiler	2	10						
13. setting the boiler	1	10						
14. waiting for boiling equipment	2	42						
15. move the equipment to soak TOPEX	2	15						
16. waiting for soaking TOPEX	2	45						
17. cleaning arm and wrapper	1	30						
18. cleaning conveyor	1	10						

Table 4.5: Flow process chart of cleaning process when changing product from mixed chocolate pattern to mixed chocolate pattern (before implementation)

Flow Process Chart										
Activity: Changing from mixed chocolate pattern to mixed chocolate pattern					Summary					
					Activity		Numbers of steps			
					Operation		23			
					Transporation		8			
					Delay		5			
					Inspection		0			
					Store		0			
Activity: Changing from mixed chocolate pattern to mixed chocolate pattern										
	QYT	Time	Symbol							
Describe	(People)	(Mins)								
Operator										
1.cleaning freezer	1	10								
2.remove filler	1	38								
3.waiting for remove mould	1	5								
4.remove mould	1	58								
5.seal mould	1	65								
6. go to get the next raw material	1	10								
7. waiting for the next raw material	1	15								
8. receive the next raw material	1	10								
9. move to the machine	1	10								
10.waiting for cleaning tank	1	10								
11. cleaning tank	1	225								
12. assembly of tank	1	20								
Assistant										
1. remove filler	1	38								
2.remove mould	1	58								
3.seal mould	1	65								
4. cleaning seal mould	1	30								
5. move to get vacuum tube	1	15								
6. move to get boiling water	1	5								
7. boiling mould	1	42								
8. removing boiled water	1	30								
9. move to get TOPEX	1	5								
10. soaking by TOPEX	1	46								
11. removing TOPEX	1	30								
Workers 1, 2, 3 & 4										
1. remove old mixed in tank	1	45								
2.cleaning mould on machine	1	38								
3.cleaning filler & hopper	2	32								
4. move old filler to storage	2	32								
5. move equipment to the boiler	2	10								
6. setting the boiler	1	10								
7. waiting for boiling equipment	2	42								
8. move the equipment to soak TOPEX	3	15								
9. waiting for soaking TOPEX	3	45								
10.assembly filler	4	45								
11. cleaning arm and wrapper	1	30								
12. cleaning stick inserter	1	40								
13. cleaning conveyor	1	10								

From table 4.1 – 4.5, it can conclude that there are a number of ineffective tasks such as transportation and waiting processes, which waste a lot of time of changeover time. Therefore, should reduce all of waiting processes as much as possible.

4.2.2 Long freezing Time

There are many cooling methods such as put inside the freezer, or use salt. In the existing freezing process, it uses salt water to freeze the ice-cream, because it is cheap and availability.

“When the salt molecules dissolve in the water, this means that the number of water molecules able to be captured by the ice (frozen) goes down, so the rate of freezing goes down. Therefore, it can conclude that the higher the concentration of salt, the lower the freezing point drops. Nevertheless, salt water also has the limited when it is in the low temperature about -21.1°C, the salt begins to crystallize out of solution, which effect to the product” (Willis, 1996).

There are three procedures in this process that are presented in the following:

1. Mixed salt water in the appropriate rate, depending on room temperature.
2. Pump the salt water into the equilibrium, which is located below the machine.
3. In this equilibrium, there is coil to exchange the heat from mixed ice-cream in mould to salt water.

This freezing process spends an amount of time that is approximately 30 minutes. For that reason, the company cannot support the product in time especially in peak periods. Therefore, it will lose the customers’ satisfaction, which is the most significant factor to get more market share. To support the production plan volumes or customers’ demand, should increase ideal production volumes by speed up freezing process.

4.3. Improvement

There are two main causes of over ideal production volumes that are taking a long time in cleaning and freezing time. For solving the critical problem, should understand the root causes of each problem by using why-why analysis.

4.3.1 Long set up time

To reduce cleaning time, should shorten critical parts' problems by using improvement techniques such as ECRS technique. The cleaning of each part is shown in figure 4.12.

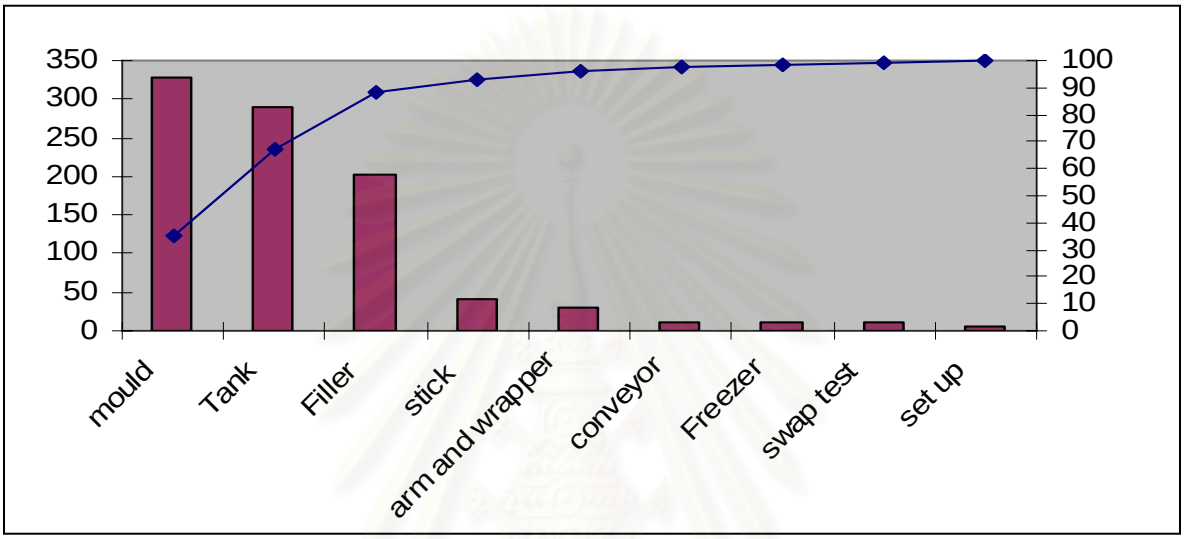


Figure 4.12: Each part cleaning process

From figure 4.12, it can conclude that it takes a long time in cleaning mould and tank processes, so we should concentrate on these parts first.

4.3.1.1 Cleaning mould

In this machine, there are two moulds for producing different product's characteristic. Since it takes a long time in cleaning mould, should know which procedures take the most of its time, shown in figure 4.13.

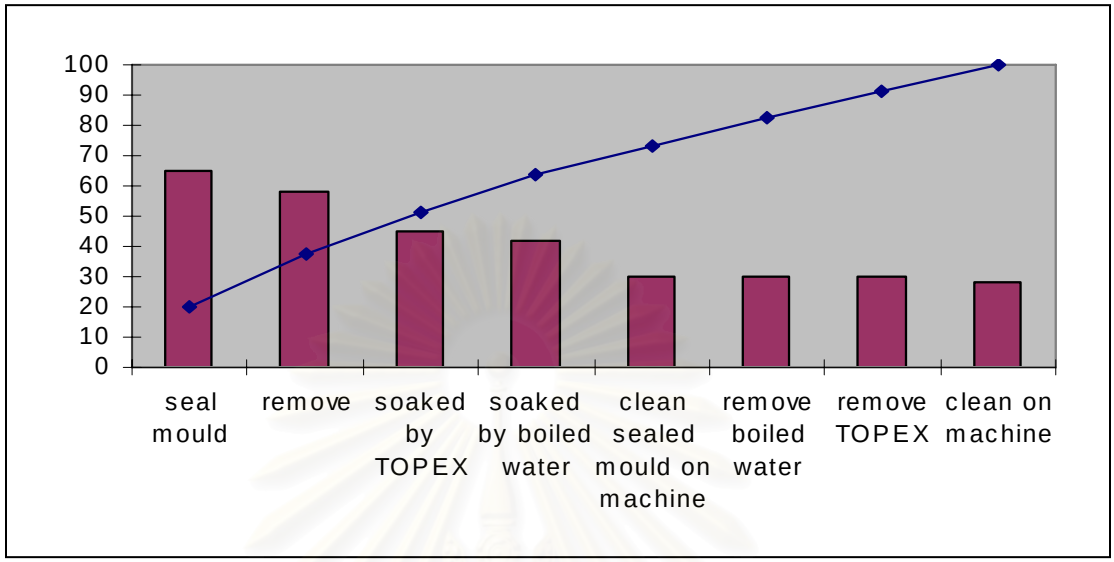


Figure 4.13: Cleaning mould

From figure 4.13, it can conclude that it takes a long time in sealing and removing mould, and soaked by TOPEX and boiled water in respectively. To solve these problems effectively, should find the real causes by using why-why analysis.

- **Why-Why analysis**

Using why-why analysis to tell the root cause of each critical problem in cleaning mould process. Moreover, this analysis also finds the possible solutions for each of them too, shown in table 4.6 and 4.7.

Table 4.6: Why-why analysis (Taking a long sealing and removing times)

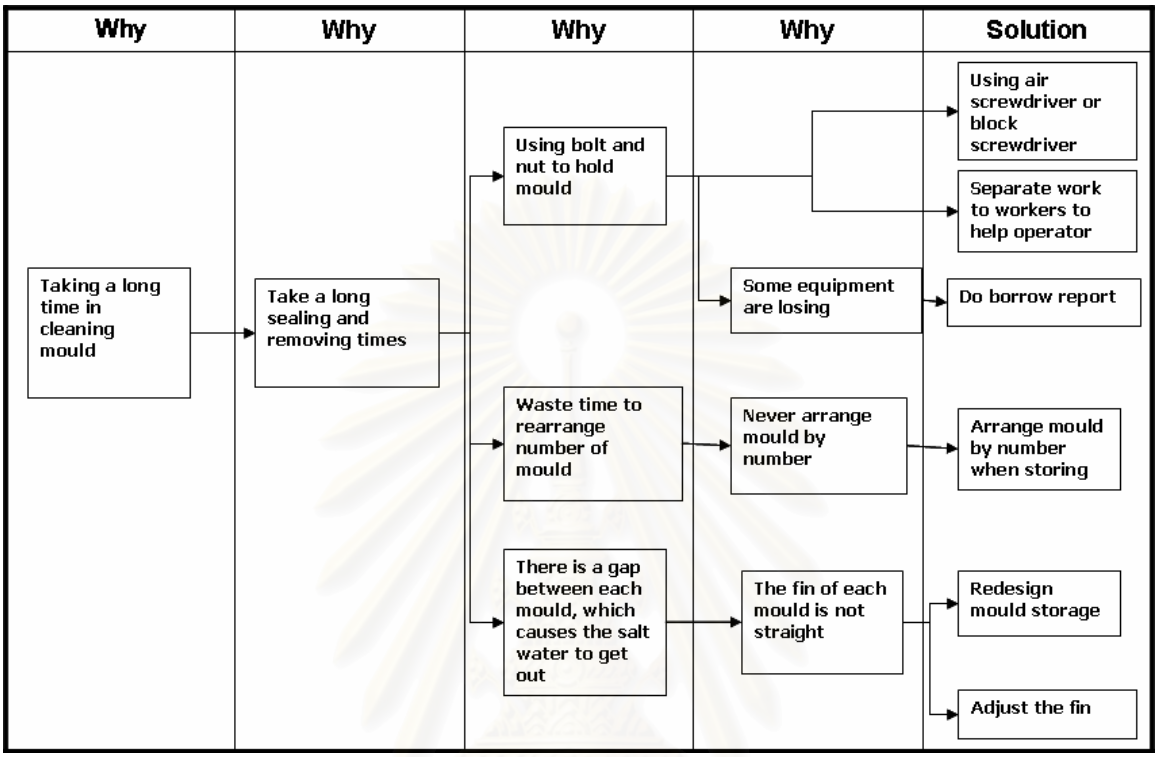
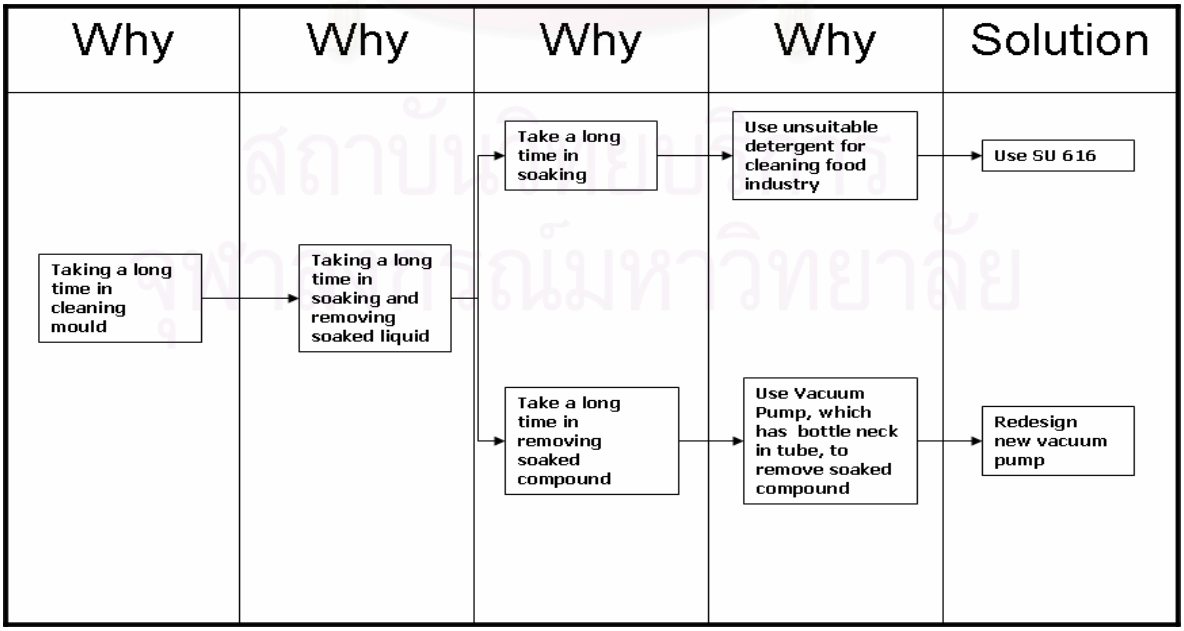


Table 4.7: Why-why analysis (Taking a long time in soaking and removing soaked liquid)



From table 4.6 and 4.7, it can conclude that the there are two main causes of taking a long time in cleaning mould that are taking a long time in sealing and removing mould, and in soaking and removing soaked liquid. Each of them comes from multiple reasons.

4.3.1.2. Cleaning Tank

Since the most frequency of cleaning machine in this line has to clean tank, cleaning tank is the important constraint process to control overall cleaning time. As a result, it can assume that if cleaning tank process takes a long time, it will effect to take a long overall cleaning time too. Therefore, should find the critical procedure in cleaning tank process, shown in figure 4.14.

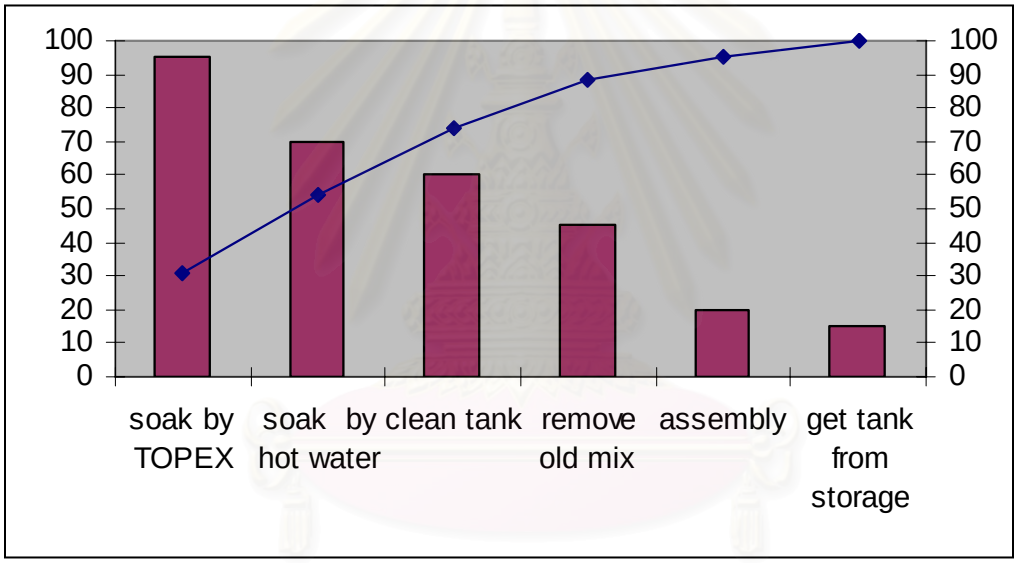


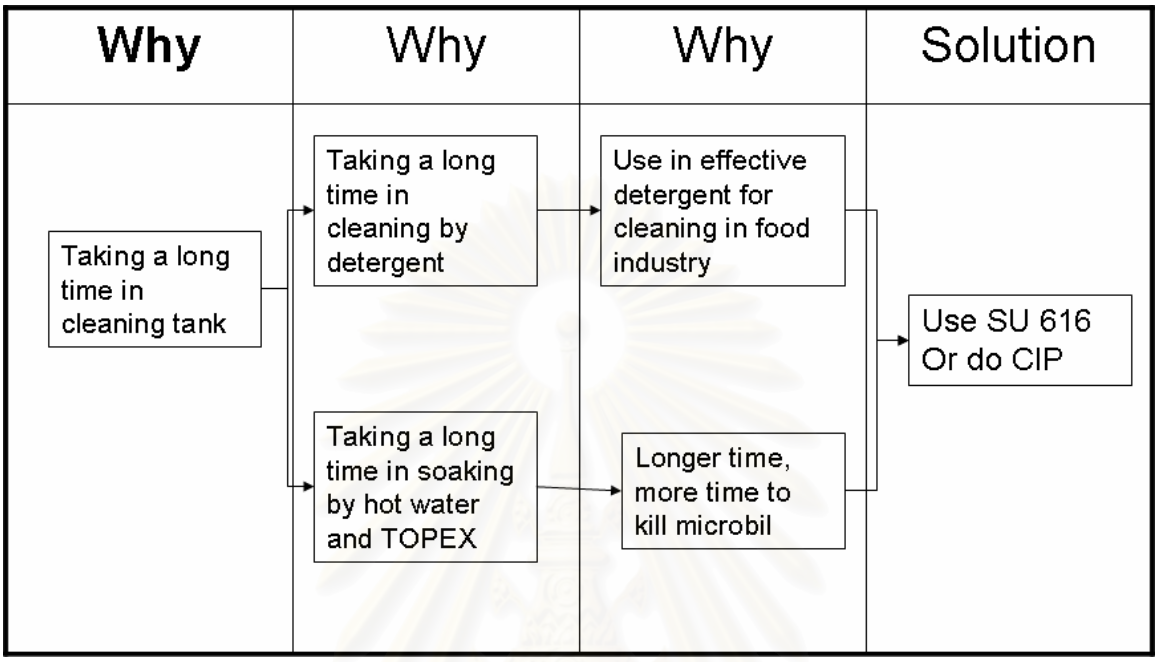
Figure 4.14: Cleaning tank

From Pareto in figure 4.14, it can conclude that the main reasons of taking a long time in cleaning tank are soaking by TOPEX and hot water, and cleaning tank by detergent. For solve the problems definitely, should analyse by why-why method to find the root causes and the solutions.

- **Why-Why analysis**

Using why-why analysis to understand the root causes of critical problems that are taking a long time in cleaning tank by detergent, and soaking by hot water and TOPEX, shown in table 4.8.

Table 4.8: Why-why analysis in cleaning tank



From table 4.8, it can conclude that there are two main causes of taking a long time in cleaning tank that are taking a long time in detergent cleaning and in soaking by hot water and TOPEX. Both of them can be solved by the same solutions.

For solving all of critical problems in cleaning process, should use the effective improvement method that is ECRS technique.

4.3.1.3. ECRS Technique

ECRS Tool is one of the most important engineering techniques for doing quick changeover, combining with E: Eliminate, C: Combine, R: Rearrange, and S: Simplify.

4.3.1.3.1. E: Eliminate

The main reason of taking a long time in cleaning process is there are a number of unnecessary processes such as waiting and transportation tasks. For improving process to be more efficient, should eliminate all of these jobs.

- Arrange mould by number

In this machine, there are 12 moulds, which can divide into two types that are 6 active and 6 reactive moulds. The active moulds have the odd number on the mould that are 1, 3, 5, 7, 9 and 11, and the reactive moulds have the even number that are 2, 4, 6, 8 and 10. When sealing mould should put reactive first and then put active. On the other hand, when removing mould should remove active first and then remove reactive mould, shown in figure 4.15.

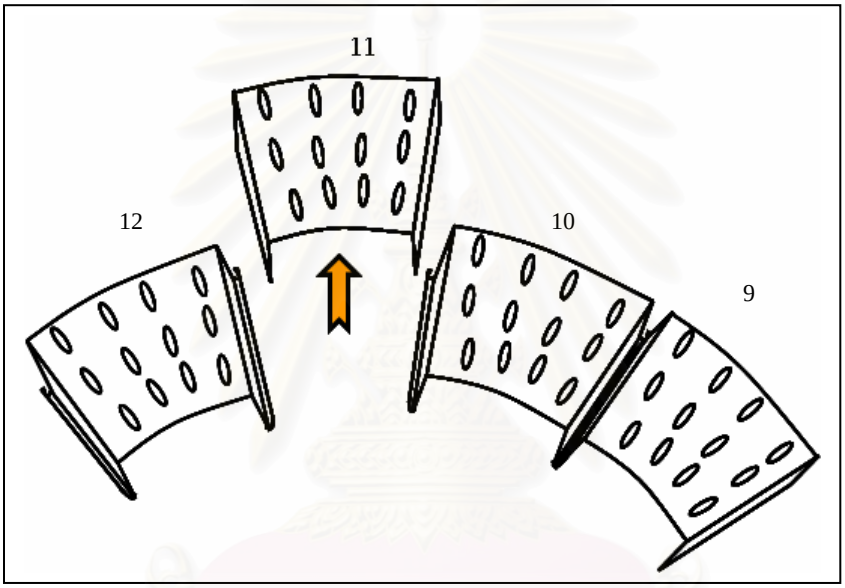


Figure 4.15: Removing mould

Thus, for time reduction, should rearrange mould storage. This improved activity is not only reduce waste time but also help workers to do their job much easier. When removing mould should remove active moulds first and arrange them by number into the same row. After that, remove the reactive moulds and also put them into the same row. In each row should arrange moulds by number. For that reason, when using them in the next time, it will take a shorten time in sealing process, shown in figure 4.16.

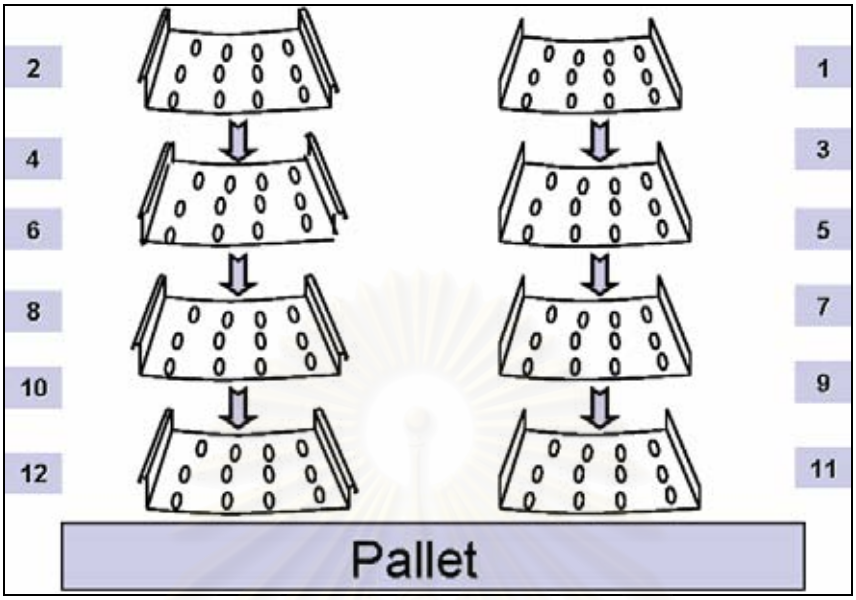


Figure 4.16: Arrange mould by number

- The fin of each mould is not straight

Since put mould on pallet in vertical line, the mould weight, which is about 27.5 kg per each, will press the fin of the bottom to be bended, shown in figure 4.17.

Figure 4.17: Putting mould on pallet

For the reason of the bended fin, the salt water, which uses for ice-cream freezing, will get out of a gap between active and reactive mould. As a result, microbial will multiple at that gap, which will effect to the end-product.

To solve this problem, when the operator seals moulds, he has to adjust the fin of each mould to be straightened first. After that, uses rubber tubes to prevent the slipped solution at every gap. For that reason, it is the main cause of taking a long time in sealing mould, shown in figure 4.18.

Figure 4.18: Sealing mould

Since the bended fin is caused by the pressing from the top mould to the below, should change the way to keep mould. For that reason, should redesign new mould pallet from keeping in vertical line to be in horizontal line. There are two drawing sketches, shown in figure 4.19.

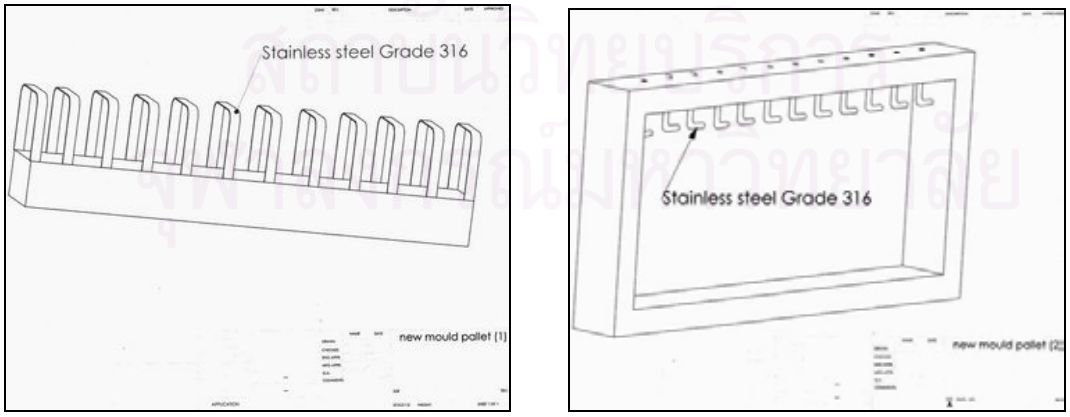


Figure 4.19: Drawing sketches of new mould pallet

From figure 4.19, both of them keep moulds in the horizontal line. On the left, have partitions to separate each mould. On the right, will use hooks to hang each mould, which not only separate each mould but also lack of pressing from the mould weight. To build both of these sketches, should create two pallets for separating the odd and even numbers, which will help when seal mould. However, before rebuild mould pallet, should repair the fins of each mould first.

- Taking a long time in removing hot water and TOPEX in cleaning mould process

In cleaning mould process, removing liquid that are water for draining fat, detergent, and TOPEX should use vacuum tubes to suck it. However, existing vacuum tubes have bottle neck at the bottom, shown in figure 4.20 and 4.21.

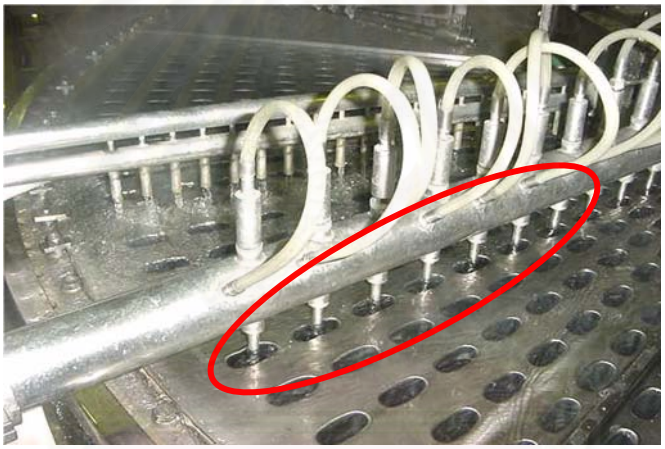


Figure 4.20: Existing vacuum tubes

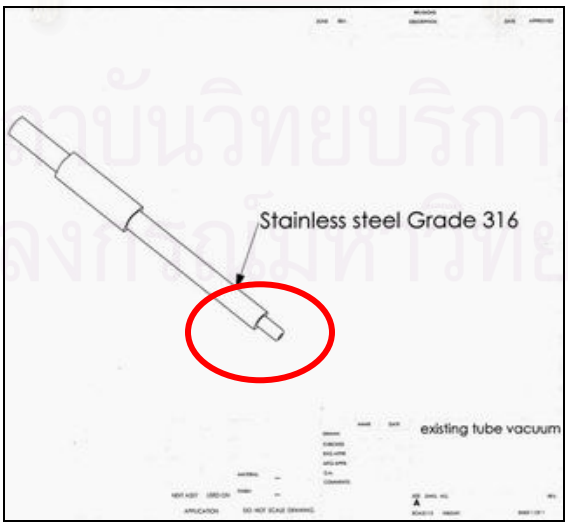


Figure 4.21: Drawing sketch of existing vacuum tube

From figure 4.20 and 4.21, it is shown that in the bottom of the existing vacuum tube has the bottle neck. Thus, when they suck liquid or some dirt, the dirt will be stuck. For that reason, the stuck dirt will obstruct for sucking, which will effect to takes a long time for removing liquid. Hence, the existing tubes cannot remove liquid in the first time. They have to do it in seven times, which is about 30 minutes, shown in figure 4.22.

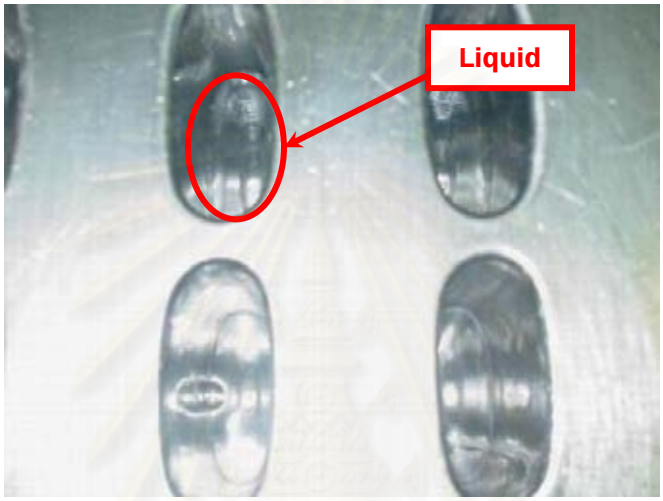


Figure 4.22: The remained liquid

From figure 4.22, it is shown that there is remained liquid after suck by the existing vacuum tubes in one time. Therefore, for the sucking time reduction, should redesign vacuum tubes by get rid of bottle neck. For that reason, they can suck liquid without remaining in the first time. The drawing sketch of these new tubes is shown in figure 4.23.

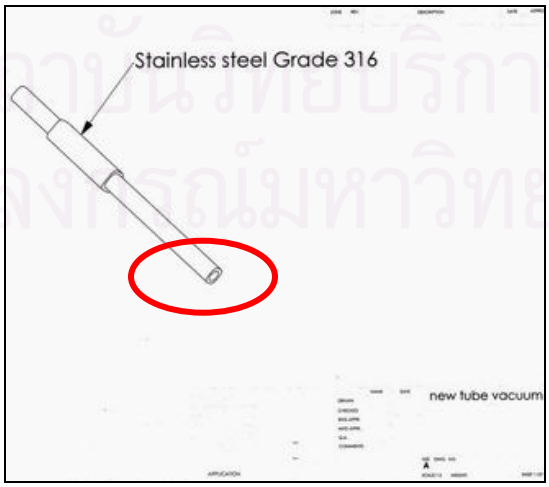


Figure 4.23: Drawing sketch of new vacuum tube

4.3.1.3.2. C: Combine

For time reduction and work more effectively, the activities, which have the same objective, should combine them into only one activity.

- Using SU 616

In cleaning process, the process should starts from bringing used equipment to the clean area. Then, clean by hot water, which is about 80°C, to wash up the old mixed, and followed by using detergent to drain the fat. After that, clean by hot water to rinse detergent. Finally, to ensure that there is no microbial left behind should soak by hot water and TOPEX, which is a sterilizer. The existing cleaning process is shown in figure 4.24.

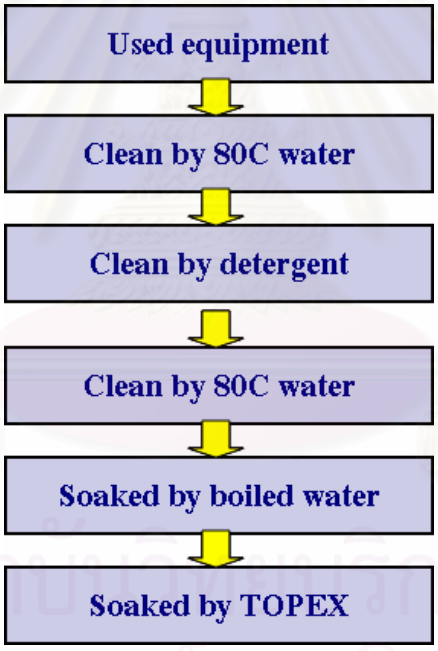


Figure 4.24: Existing cleaning process

From figure 4.24, it can conclude that there are six steps in existing cleaning process. This process takes a very long time that is about 167 minutes. Moreover, each procedure in this process also has the same objective that is rinse dirt and kill microbial in the same time. For that reason, should combine these procedures into one activity. Besides, detergent is not a suitable cleaning agent for using in food and beverage industries, shown in table 4.9.

Table 4.9: Advantages and Disadvantages of Detergent

Pros	Cons
1. Availability 2. Cheap 3. Do not use any accessories 4. Suitable for clean small equipment	1. Still skid after cleaning especially in huge area 2. Only cleaner, so lose a lot of time to soaked by killing microbial compound

From table 4.9, it can conclude that detergent is not suitable for cleaning in food and beverage industries, because there is still skid after cleaning. Therefore, should change the cleaning agent to the effective one, which is not only can clean fat without skidding but also combines the existing procedures.

SU 616 is the effective cleaning agent, which always uses in food and beverage industries. It can clean sticky dirty and fat, which always occur in these manufacturer. Moreover, it is a cleaner and a sterilizer in one, so it is very convenient for usage. Its advantages and disadvantage are shown in table 4.10.

Table 4.10: Advantages and Disadvantages of SU 616

Pros	Cons
1. Can clean sticky dirty 2. Has small particals, so can wipe out fat easily 3. Not only cleaner but also can kill dangerous microbial (soaked only 15 minutes) 4. Can clean in large area 5. Can use with hot water, which is different from the others 6. Normally apply in food industries	1. Has to use with pressure equipment to release its foam 2. Not suitable for cleaning small equipment

Since SU 616 is not only a cleaner but also a sterilizer, it can combine some existing procedures that are the third stage through the last stage. However, since SU 616 is a strong alkaline, should add another stage that is clean by hot water to rinse SU 616 from cleaned equipment. The objective of doing this stage is to ensure that there is no alkaline in the end- product, which will be the food poisoning.

For that reason, it can conclude that the new cleaning process when using SU 616 has only four steps that are bring the used equipment to the clean area, and then clean by hot water to wash up the old mixed. After that, use SU 616 to clean equipment and to kill microbial. Finally, clean by hot water to rinse SU 616, shown in figure 4.25.

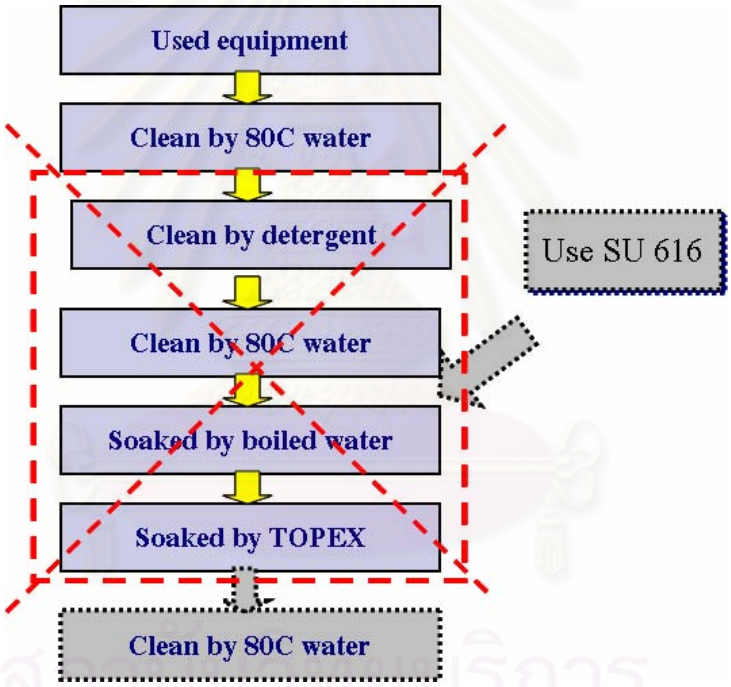


Figure 4.25: Using SU 616

However, SU 616 is suitable for cleaning only in huge area not in small equipment. Consequently, should use only for cleaning mould, tank and floor. On the other hand, for cleaning the small equipment should use the existing process to clean it.

4.3.1.3.3. R: Rearrange

To get successful job, should rearrange every task in the potential sequence, which use resource and do motion in the most effective way, shown in figure 4.26 – 4.30.

Figure 4.26: Gantt chart of cleaning process when using machine 90 minutes in original pattern (after implementation) [1.38 Hrs.]

ID	part	Task Name	Resource Names	Duration	Pred
1	freezer	cleaning	operator	10 mins	
2	filler & hopper	remove filler	A&B	38 mins	1
3		cleaning	A,B&C	16 mins	2
4		get hot water & set boiler	D&E	10 mins	2
5		boiling	A,B,assist,C&D	10 mins	3
6		soaked by TOPEX	A,B,assist,C&D	15 mins	5
7		assembly	A,B,C&D,assist	11 mins	6
8	mould	clean the old mixed	assist	30 mins	1
9		cleaning by foam	operator	21 mins	8
10		remove foam	operator	35 mins	9
11	arm and wrapper	cleaning	assist	10 mins	8
12	conveyor	cleaning	assist	10 mins	11
13	stick	cleaning	C	40 mins	1
14	swap test		operator	8 mins	10
15	set up		operator	5 mins	14

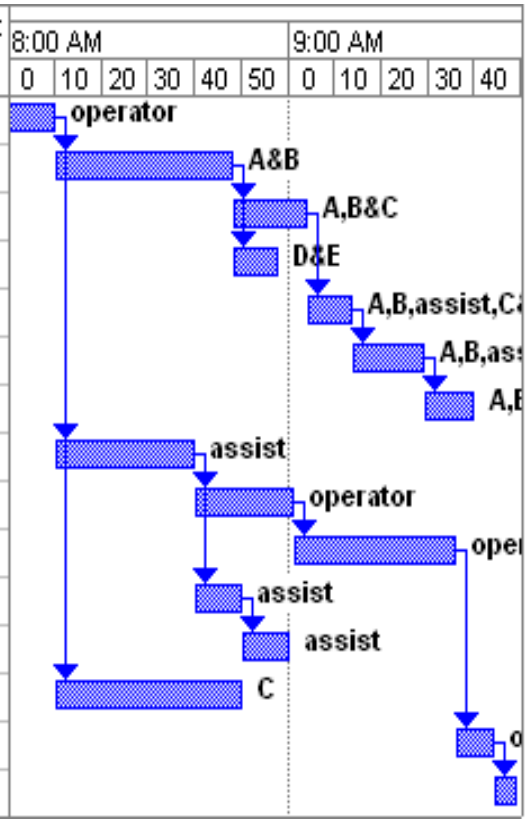


Figure 4.27: Gantt chart of cleaning process when using machine 90 minutes in mixed chocolate pattern (after implementation) [2.05 Hrs.]

ID	part	Task Name	Resource Names	Duration	Pred
1	freezer	cleaning	operator	10 mins	
2	filler & hopper	remove filler	A&B	38 mins	1
3		cleaning	A&B	32 mins	2
4		get hot water & set boiler	D&E	10 mins	2
5		boiling	A,B,assist,C&D	10 mins	3
6		soaked by TOPEX	A,B,assist,C&D	15 mins	5
7		assembly	A,B,C&D,assist	11 mins	6
8	mould	clean the old mixed	assist	30 mins	1
9		cleaning by foam	operator	21 mins	11
10		remove foam	operator	35 mins	9
11	tank	remove the old mix	C	45 mins	1
12		cleaning by foam	operator	21 mins	11
13		remove foam	operator	10 mins	12
14	arm and wrapper	cleaning	assist	10 mins	8
15	conveyor	cleaning	assist	10 mins	14
16	stick	cleaning	C	40 mins	11
17	swap test		operator	8 mins	10
18	set up		operator	5 mins	17

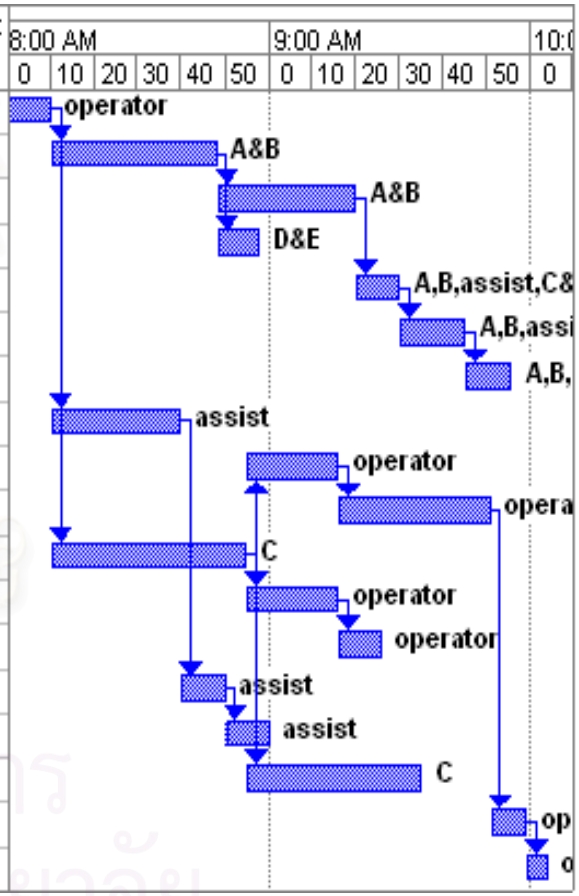


Figure 4.28: Gantt chart of cleaning process when changing product from original pattern to original pattern (after implementation) [2.45 Hrs.]

ID	part	Task Name	Resource Names	Duration	Pre
1	freezer	cleaning	operator	10 mins	
2	filler & hopper	remove filler	A	38 mins	1
3		cleaning	B&C,A	16 mins	2
4		boiling	B&C,A	10 mins	3
5		soaked by TOPEX	B&C,A	15 mins	4
6		assembly	B&C,A	15 mins	5
7	mould	clean on machine by foam	operator	12 mins	1
8		remove mould	oper/assist,D&	57 mins	7
9		seal mould	oper/assist,D&	26 mins	8
10		clean sealed mould by foam	operator	21 mins	9
11		remove foam	operator	35 mins	10
12	arm and wrapper	cleaning	assist	30 mins	1
13	conveyor	cleaning	assist	10 mins	12
14	stick	cleaning	C	40 mins	1
15	swap test		operator	10 mins	11
16	set up		operator	5 mins	15

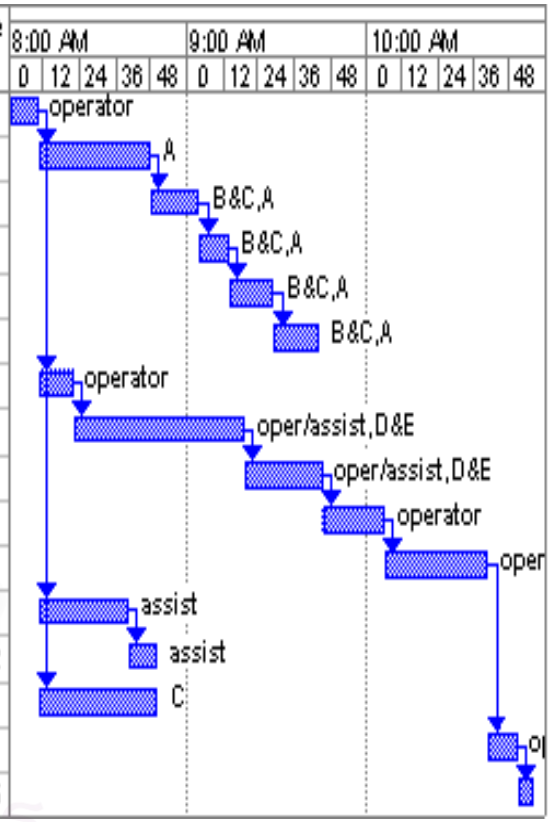


Figure 4.29: Gantt chart of cleaning process when changing product from original pattern to mixed chocolate pattern (after implementation) [3.15 Hrs.]

ID	part	Task Name	Resource Names	Duration	Pre
1	freezer	cleaning	operator	10 min:	
2	filler & hopper	remove filler	A	38 min:	1
3		cleaning	B&C,A	16 min:	2
4		boiling	B&C,A	10 min:	3
5		soaked by TOPEX	B&C,A	15 min:	4
6		assembly	B&C,A	15 min:	5
7	mould	clean on machine by foam	B&C	12 mins	1
8		remove	oper/asslst,D&E	57 mins	13
9		seal mould	oper/asslst,B,C,D&E	26 mins	8
10		clean sealed mould by foam	operator	21 mins	9
11		remove foam	operator	35 mins	10
12	tank	get tank from storage	D	15 min:	
13		Remove old imbed	D	45 mins	12
14		cleaned by foam for used and new one	operator	21 min:	9
15		assembly	operator	20 min:	14
16	arm and wrapper	cleaning	asslst	30 min:	1
17	convevor	cleaning	asslst	10 min:	16
18	stick	cleaning	E	40 min:	1
19	swap test		operator	10 min:	11
20	set up		operator	5 mins	19

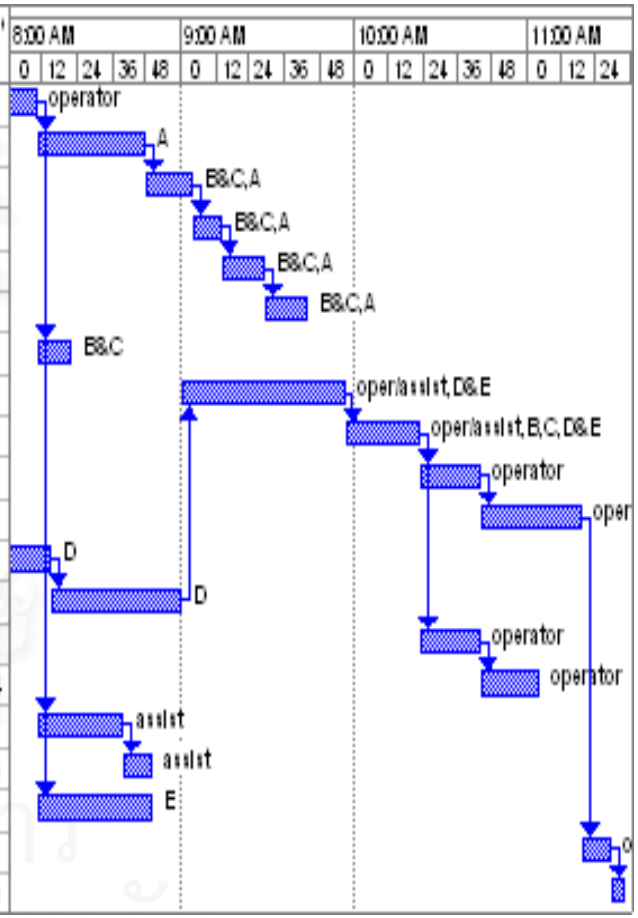
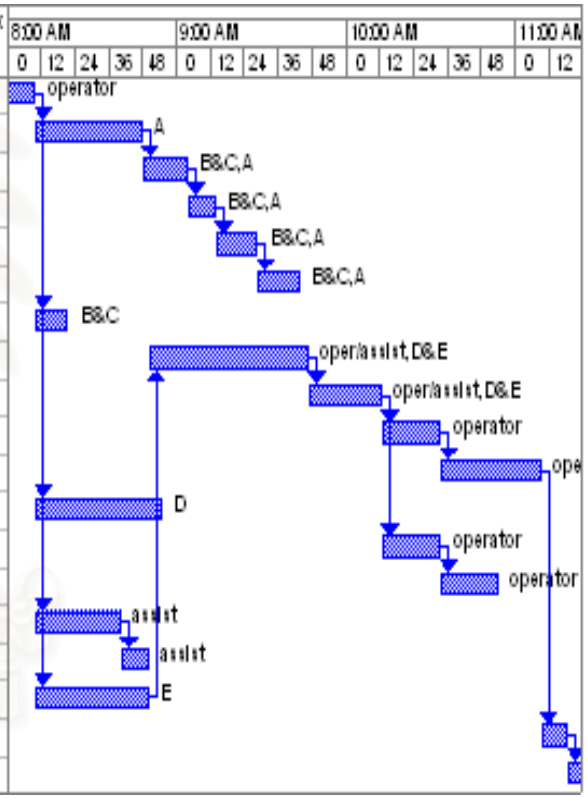


Figure 4.30: Gantt chart of cleaning process when changing product from mixed chocolate pattern to mixed chocolate pattern (after implementation) [3.12 Hrs.]

ID	part	Task Name	Resource Names	Duration	Prec
1	freezer	cleaning	operator	10 mins	
2	filler & hopper	remove filler	A	38 mins	1
3		cleaning	B&C,A	16 mins	2
4		boiling	B&C,A	10 mins	3
5		soaked by TOPEX	B&C,A	15 mins	4
6		assembly	B&C,A	15 mins	5
7	mould	clean on machine by foam	B&C	12 mins	1
8		remove	oper/asslst,D&E	57 mins	17
9		seal mould	oper/asslst,D&E	26 mins	8
10		clean sealed mould by foam	operator	21 mins	9
11		remove foam	operator	35 mins	10
12	Tank	Remove old mbed	D	45 mins	1
13		cleaned by foam for used and new ones	operator	21 mins	9
14		assembly	operator	20 mins	13
15	arm and wrapper	cleaning	asslst	30 mins	1
16	conveyor	cleaning	asslst	10 mins	15
17	stick	cleaning	E	40 mins	1
18	swap test		operator	10 mins	11
19	set up		operator	5 mins	18



From figure 4.26 – 4.30, it can conclude that in these rearranged processes, they have already applied some effective techniques from the previous idea such as using SU 616, and also adjust some tasks to do in parallel time. For that reason, it can reduce an amount of time especially in the critical parts.

4.3.1.3.4. S: Simplify

Simplify is one of the most important techniques to improve work methods by making them more convenient. The most significant techniques for doing this are visual system and ergonomic theory.

- Tool Box

Nowadays, the company keeps tool in the tool tray, shown in figure 4.31. For that reason, it takes time to find wanted tool, because it keeps tool unordered. Moreover, some tools are losing.

Figure 4.31: Tool tray

Therefore, should use 5S that are SEIRI, SEITON, SEISO, SEIKETSU and SHISUKE to order the tools by design a tool chart or a tool box, which helps to find tools easier. Furthermore, should design tool table to record who borrow tool, which will solve the tool losing problem.

- Screw drivers

In this machine, uses a number of bolts and nuts that are about 48 pieces to hold every mould together with the machine. For that reason, it also effect to take a long time in sealing and removing mould. Therefore, for sealing and removing mould more quickly, should use some helpful equipment such as block screw drivers or air screw drivers.

- pH metre

From previous idea, it can assume that should change huge areas' cleaning agent from detergent to SU 616, which is a strong alkaline. Therefore, after use this solution, should check pH value to be equal 7 – 8, which is a neutral. In the existing process, use litmus paper, which take a long time for observation. Moreover, for getting the right result, should let skill employee to do it, shown in figure 4.32.

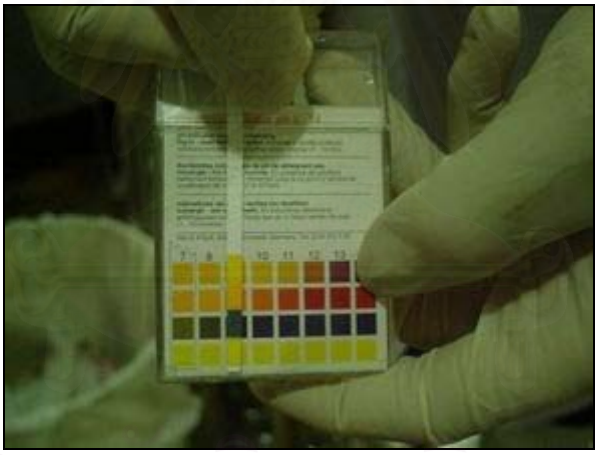


Figure 4.32: Litmus paper

Consequently, should use electronic equipment such as pH metre to help, because it is not only get correct result but also easy to use for every employee.

- Table for cleaning

Since there is not suitable equipment for small equipment's cleaning process, the workers will get exhaust from their bad working behaviours, shown in figure 4.33.

Figure 4.33: Existing cleaning behaviour

From figure 4.33, it can conclude that this is the bad working behaviour. This behaviour will cause the problem to the worker's physic and the worker's psychology. All of these will effect to their working ability to be worse than usual.

Therefore, should design suitable equipment for small equipment's cleaning process that is table for cleaning. It is designed by using ergonomic theory. For that reason, it will be suitable for working area and workers' work. Its drawing sketch is shown in figure 4.34.

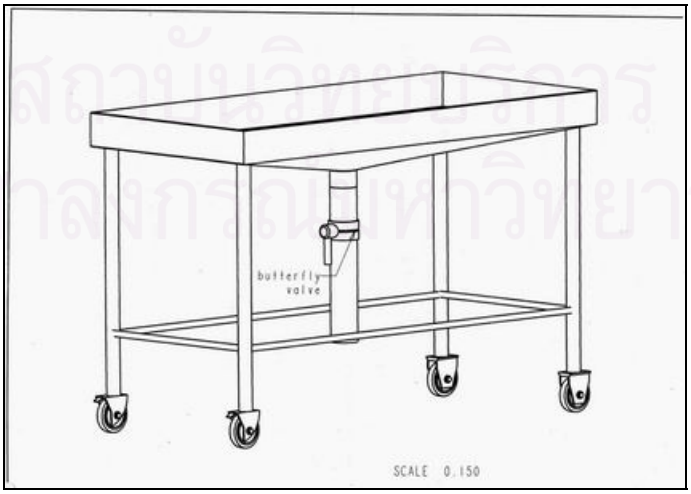


Figure 4.34: Drawing sketch of table of cleaning

- O-ring keeper

In this machine, it uses o-rings in every small tool to avoid friction when machine running, so there are many sizes of them. Therefore, after cleaning, always take an amount of time for assembly them in correct tools. In the existing cleaning process for o-rings, the workers put all of them in the tray, shown in figure 4.35, and clean them by following the seven steps of cleaning process. For assembly, the workers have to trail the right o-ring to the right tool, which takes an amount of time.

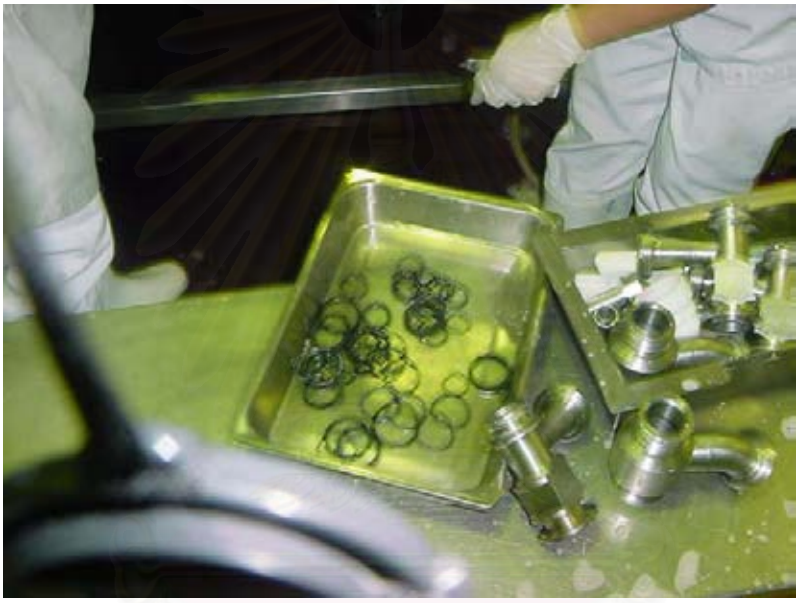


Figure 4.35: Existing o-ring's cleaning process

Therefore, to work more easily, should design o-ring keeper, which separates o-ring in each size during cleaning process. For that reason, the workers will know the o-rings' size, and can assemble them in the right tool faster. There are two drawing sketches for o-ring keeper, shown in figure 4.36.

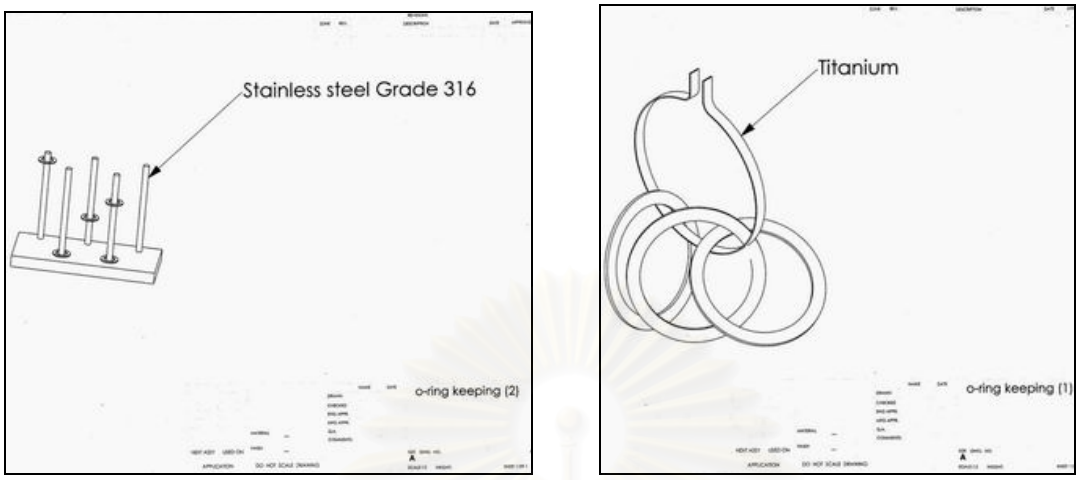


Figure 4.36: Drawing sketches of o-ring keeper

4.3.2 Long freezing time

4.3.2.1 Problems

This machine takes an amount of freezing time, which is approximately 30 minutes. As a result, have to use some improvement techniques or some equipment to help and to eliminate the root causes of this problem. To analyse the roots casuses should use why-why analysis, shown in table 4.11.

Table 4.11: Why-Why analysis in freezing process

Why	Why	Solution
Taking a long time in freezing process	Taking a long time for setting an appropriate freezing point	Setting the rate of mixing of salt water to get an appropriate freezing point
		Using liquid nitrogen, which get the lower freezing point
	Taking a long time for transfer the heat	Using liquid nitrogen, which can freeze in the shorten time

From table 4.11, it can conclude that the long freezing time comes from two main reasons that are taking a long time for setting an appropriate freezing point, and for transfer the heat between the mixed ice-cream and salt water. Therefore, for freezing time reduction, should use ECRS technique to eliminate all of those root causes.

4.3.2.2 ECRS Technique

4.3.2.2.1 E: Eliminate

From why-why analysis, the optimize solution to eliminate all of the long freezing time's root causes is changing freezing agent from salt water to liquid nitrogen. Liquid nitrogen is a widely chemical solution in ice-cream manufacturer, because it can freeze the ice-cream in the shorten time, and does not effect to ice-cream favour or hygiene. Besides, using liquid nitrogen can also eliminate some critical tasks.

Using liquid nitrogen drops only one droplet into the mixed ice-cream, and then it will be freezed in the shorten time. For that shorten procedures, it can conclude that it eliminates a number of duplicate and unnecessary procedures, which will effect to reduce an amount of freezing time.

For example, it eliminates mixing salt water in the appropriate rate, depending on room temperature. This appropriate rate will not generate crystallization, and has a suitable freezing point. Moreover, it also eliminates some procedures, which use only for salt water, such as pumping salt water into the equilibrium. The existing and new freezing processes are shown in figure 4.37 and 4.38.

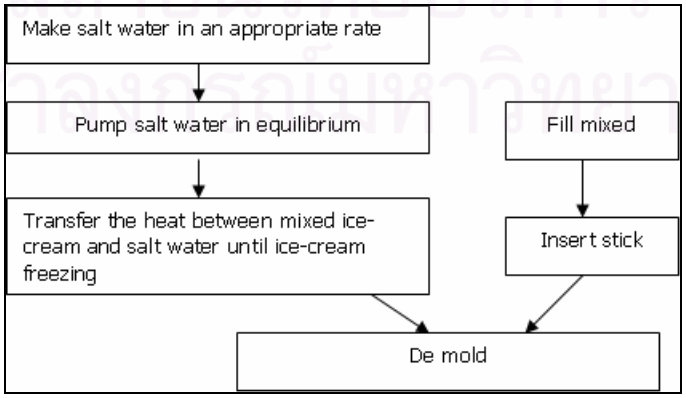


Figure 4.37: The existing freezing process

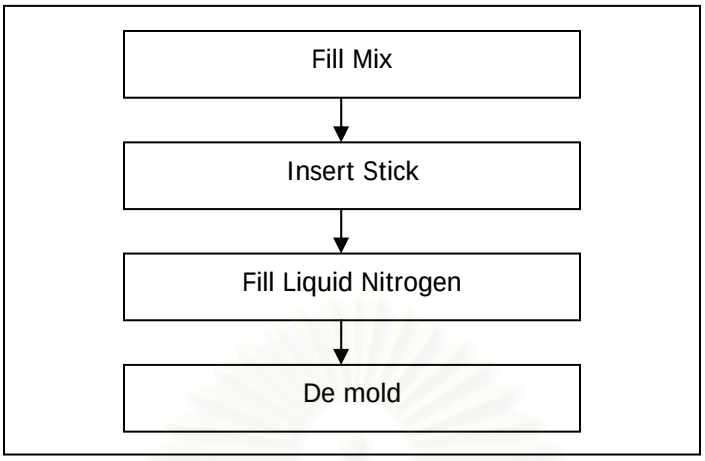


Figure 4.38: Using liquid nitrogen for freezing process

In the existing process, the freezing point is controlled by the rate of mixing salt water, depending on the room temperature. Therefore, when the room temperature changes, the rate has to change too. Consequently, it wastes an amount of time for changing it into the appropriate rate. For that reason, it cannot support the product in time for the customers' requirement obviously in the peak periods.

On the other hand, liquid nitrogen does not get the effect like that, because its characteristic has the constant and suitable freezing point. As a result, its freezing point will not change even in the peak period, shown in table 4.12.

Table 4.12: Temperature in freezing process

	Filled with LN_2	**Regular Condition**
1	-13.3 °C	-6.9 °C
2	-15.7 °C	-7.2 °C
3	-17.8 °C	-8.7 °C
4	-13.3 °C	-11.4 °C
5	-17.6 °C	-8.9 °C
6	-19.2 °C	-9.6 °C
7	-19.7 °C	-9.3 °C
Average	**-16.66 °C**	**-8.86 °C**

From table 4.12, it shows the example of seven products, which produce in the peak period (in October). In this table, it compares the products from using liquid nitrogen with using salt water to freeze the ice-cream. The specific ice-cream should be -15°C before de mold, because in this temperature, the product will get a good shape. Hence, liquid nitrogen usage is more suitable than the existing process, shown in figure 4.39. In figure 4.39, it is shown the products, which are used liquid nitrogen and salt water to freeze ice-cream. One the left, it uses liquid nitrogen, and on the right, it uses salt water to freeze.

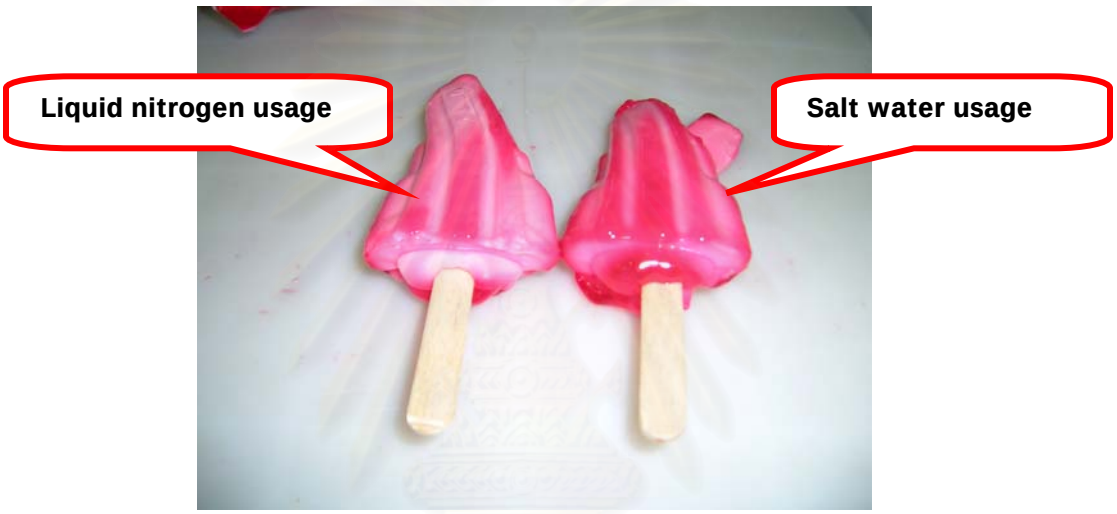


Figure 4.39: Comparing the ice-creams; using liquid nitrogen and salt water

From figure 4.39, the product, which is freezed by liquid nitrogen, gets the better shape, because the ice-cream does not get the appropriate freezing point in salt water process. Hence, using liquid nitrogen will be better, because the company is not only can reduce freezing time but also can get the better products.

Moreover, since liquid nitrogen can help the company to shorten freezing time, the ideal production volumes will also increase. The production stroke will increase from 16 strokes/min to 21 strokes/min that will increase the ideal production volumes. It can conclude that should use liquid nitrogen to be a freezing agent, because it is not only help the company to freeze ice-cream in the shorten time but also increase production speed.

However, liquid nitrogen is also a hazardous solution, because it can burn employees' hand if they touch it. Therefore, for ensure that it will not occur that happen, have to use some

automatic equipment to help. In this case, have designed the equipment to fill liquid nitrogen automatic by using the same stroke as production's.

In addition, there is another problem that is in this case, should drop liquid nitrogen in the open system. For that reason, it causes the heavy thick fog, which cover to the top of the machine. This fog will not dangerous to the operator, but it will effect to operate the machine, shown in figure 4.40.

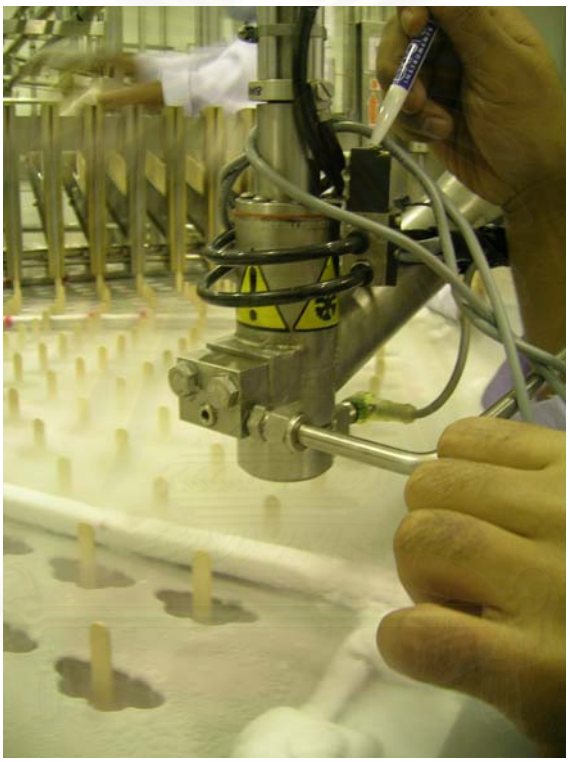


Figure 4.40: The heavy thick fog

As a result, for solving this problem should design the exhaust pipe, which sets up nearby the operating area for a safety purpose. The drawing sketch of liquid nitrogen releaser and its exhaust pipe is shown in figure 4.41.

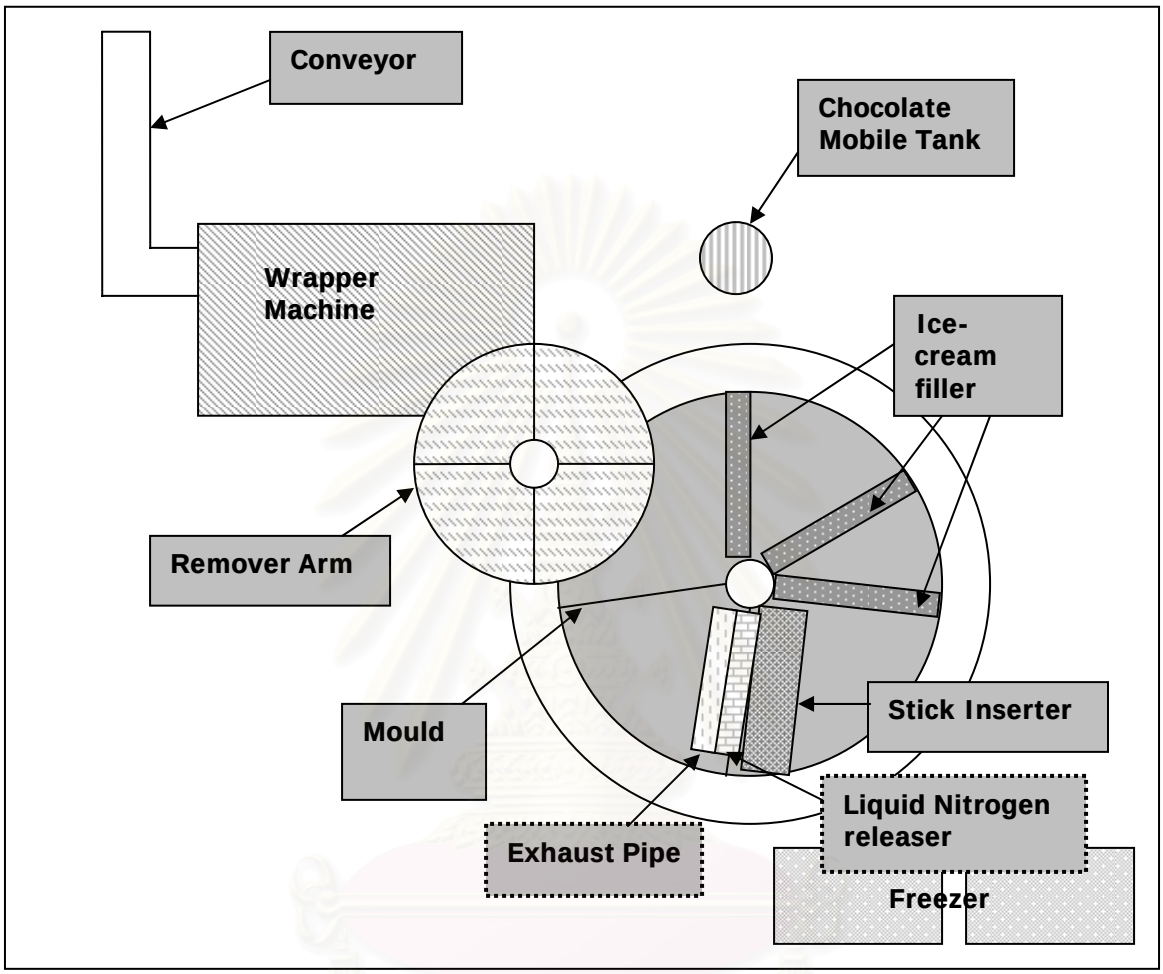


Figure 4.41: Drawing sketch of liquid nitrogen releaser and exhaust pipe

From figure 4.41, it can conclude that the liquid nitrogen releaser will release nitrogen, following the stroke of the machine. It will set next to machine inserts stick, so liquid nitrogen will freeze the mixed ice-cream in time before de mold. The exhaust pipe will set next to the liquid nitrogen releaser to suck the heavy fog on the top of machine, which occurs when release liquid nitrogen. This exhaust pipe will connect to mixing department, which is responsible for production waste.

CHAPTER V

IMPLEMENTATION

In this thesis, the implementation consists of two important stages that are planning stage to plan the process improvement with involved staffs, and economic evaluation stage to choose the best and worth solution. The details of each stage are presented in the following:

5.1 Planning

Planning stage is one of the most significant stages especially in process improvement project. It consists of a vital method that is involved staffs meeting. The main purposes of this essential method are to combine every involved staff's decisions, and apply them in the same objectives. This meeting is not only participates with involved staffs but also manager. Manager will compare the project with company's budget. In this thesis, there are a number of meetings to approve and assign work.

5.1.1 Long set up time

In a long set up time, there are about six times of meeting. All of these meetings participate with the involved people that are manager to compare the process with the budget, supervisors in packing department to contact dealers if want some outsourcing, supervisors in research and development department to develop new equipment for process improvement, and operator and workers who understand the real situation and problems.

The meeting reports in this project are shown in the following:

- **The first meeting**

Date 15/6/06 at 15.00-16.30 Place: TPM meeting room
Participated: The supervisors in packing department, the supervisors in research & development department, operator and workers, and Ms. Chollaya

The first meeting report is shown in table 5.1.

Table 5.1: The first meeting report in long set up time project

Topic	Problem / Presentation	Solution	Assign	Finished time
1.Production process	• Explain the production process in X line.	-	-	-
2.Cleaning process	• Explain the cleaning processes of each type.	-	-	-
	• Catch up the cleaning time to know which type of cleaning process takes the longest time and the most frequency.	-	• Ms. Chollaya	• 28/6/06
	• Catch up the problems in the cleaning processes	-	• Ms. Chollaya	• 28/6/06

- **The second meeting**

Date 28/6/06 at 15.00-16.30 Place: Packing Hall meeting room

Participated: The supervisors in packing department, the supervisors in research & development department, operator and workers, and Ms. Chollaya

The second meeting report is shown in table 5.2.

Table 5.2: The second meeting report in long set up time project

Topic	Problem / Presentation	Solution	Assign	Finished time
1.Set up time	• Show the graph of set up time in each type of cleaning processes. It is found that all of them take a very long time. The average is about 7.29 Hrs.	-	-	-

Table 5.2: The second meeting report in long set up time project (Continued)

Topic	Problem / Presentation	Solution	Assign	Finished time
2.Cleaning process	• Show the pareto chart of every cleaning part to know which part takes the longest time. It is found that cleaning mould and tank take the longest time that are 325 and 300 minutes in respectively.	• Do why-why analysis to find the root causes of these critical parts, and use some improvement techniques to improve these processes.	• Ms. Chollaya and operator	• 5/7/06

- **The third meeting**

Date 5/7/06 at 15.00-16.30 Place: Packing Hall meeting room
Participated: Manager in packing department, the supervisors in packing department, the supervisors in research & development department, operator and workers, and Ms. Chollaya

The third meeting report is shown in table 5.3.

Table 5.3: The third meeting report in long set up time project

Topic	Problem / Presentation	Solution	Assign	Finished time
1.Cleaning process	• Describe the root causes of taking a long time in cleaning mould and tank.	-	-	-

Table 5.3: The third meeting report in long set up time project (Continued)

Topic	Problem / Presentation	Solution	Assign	Finished time
2.Cleaning mould	• The main cause comes from the vacuum tubes, which will suck liquid in mould. They have the bottom neck, so they cannot suck liquid in the first time (should suck about 7 times, which is about 30 minutes).	• Design new vacuum tubes, which do not have the bottle neck.	• Ms. Chollaya	• 19/7/06
3. Tool	• Kept device by tool tray, which is unordered.	• Design tool chart or tool box.	• Ms. Chollaya	• 12/7/06
	• Bolts and nuts in this line are the same size, so use only screwdrivers no.19. These screwdrivers always lose, because they also use in the other lines too.	•Create tool table to know who borrow the tool.	• Ms. Chollaya	• 12/7/06
4.Cleaning behaviour	• There are ineffective work behaviours in cleaning small equipment, which will effect to work worse than the usual.	• Design ergonomic equipment such as table for cleaning, which is suitable for cleaning area and workers' physic.	• Ms. Chollaya	• 24/7/06
5.Arrange work	• Some works have too many people to do, but the others have not.	• Rearrange time and work allocation.	• Ms. Chollaya	• 26/7/06
6.Boiling and soaking TOPEX	• Present the boiling and soaking time in the existing processes.	-	-	-

Table 5.3: The third meeting report in long set up time project (Continued)

Topic	Problem/Presentation	Solution	Assign	Finished time
6.Boiling and soaking TOPEX process	• Do not have the standard time for boiling and soaking.	• Find the appropriate time for boiling and soaking in small equipment.	• Ms. Chollaya	• 12/7/06
7.Cleaning agent	• Detergent is not a suitable cleaning agent for food manufacturer especially for cleaning huge area.	• Find the suitable cleaning agent for huge area.	• Ms. Chollaya	• 17/7/06

- **The fourth meeting**

Date 2/8/06 at 15.00-16.30 Place: Packing Hall meeting room
Participated: Manager in packing department, the supervisors in packing department, the supervisors in research & development department, operator and workers, and Ms. Chollaya

The fourth meeting report is shown in table 5.4.

Table 5.4: The fourth meeting report in long set up time project

Topic	Problem/Presentation	Solution	Assign	Finished time
1. Tool	• Present the drawing of tool box. It is made of metal, which costs about 600 Baht.	• Create the tool box by following the drawing.	• Supervisors in research & development department	• 9/8/06
	• Present the tool chart.	-	-	-

Table 5.4: The fourth meeting report in long set up time project (Continued)

Topic	Problem / Presentation	Solution	Assign	Finished time
2.Cleaning behaviour	• Present the drawing of the table for cleaning. It is made of stainless steel grade 316, which costs about 45,000 Baht.	• Create the table for cleaning by following the drawing.	• Supervisors in research & development department	• 16/8/06
3.Arrange work	• Explain the rearranged processes to the operator and workers, and adapt these processes to match their activities.	-	-	-
	• Catch up time and problems of the rearranged processes.	• Create the working standard from these rearranged processes.	• Ms. Chollaya	• 23/8/06
4.Boiling and soaking TOPEX process	• Present the literature review about the appropriate time for boiling and soaking processes.	-	-	-
	• Set the standard time of boiling and soaking for cleaning small equipment.	-	-	-
	• Present the new effective cleaning agent for cleaning mould and tank that is SU616.	• Contact dealer to know the cost and the conditions.	• Supervisors in packing department	• 4/7/06
5.Cleaning mould	• Present the drawing of new vacuum tubes, which do not have the bottle neck. They are also made of stainless steel grade 316, which cost about 16,000 Baht.	• Create the new vacuum tubes by following the drawing.	• Supervisors in research & development department	• 23/8/06

Table 5.4: The fourth meeting report in long set up time project (Continued)

Topic	Problem / Presentation	Solution	Assign	Finished time
6.O-ring	• There are many sizes of o-rings. Thus, it takes an amount of time for trail each o-ring to the right equipment.	• Design some equipment to separate o-rings in each size during cleaning process.	• Ms. Chollaya	• 22/8/06
7. Mould	• Workers have to arrange mould number before sealing mould.	• Separate the odd and even numbers in the different side of pellet, and also arrange them by number.	• Operator	• 17/8/06
	• The fin of each mould is not straight.	• Repair the fins	• Supervisors in research & development department	• 3/9/06
		• This problem comes from the unsuitable mould pallet, so should design new mould pallet.	• Ms. Chollaya	• 12/9/06
	• There are a number of bolts and nuts to hold moulds with machine.	• Find some helpful tool to work much easier.	• Ms. Chollaya	• 19/8/06

- **The fifth meeting**

Date 12/9/06 at 15.00-16.30 Place: Packing Hall meeting room

Participated: Manager in packing department, the supervisors in packing department, the supervisors in research & development department, operators and workers, and Ms. Chollaya

The fifth meeting report is shown in table 5.5.

Table 5.5: The fifth meeting report in long set up time project

Topic	Problem / Presentation	Solution	Assign	Finished time
1. Arrange work	• Show the time of the rearranged processes, which can reduce about 64.78% of the existing processes.	-	-	-
2. SU 616	• SU616 is a strong alkaline. Thus, after cleaning, should check pH value to be 7-8. Nowadays, use litmus paper, which cannot read the result correctly. Moreover, only skill workers can use it. Thus, should use some electronic equipment to help that is pH metre.	• Contact the dealer to know the cost and the conditions.	• supervisor in packing department	• 13/9/06
3.O-ring	• Present the drawings of o-ring keeper, and let the operator and workers choose the suitable one for their work. All of them are made of the available material in company, so there is no extraordinary cost.	• Create o-ring keeper by following the drawing.	• supervisors in research & development department	• 15/9/06
4. Mould	• Present the drawings of new mould pallet, and let every involved staff choose the most effective one. All of them are made of stainless steel grade 316. The chosen one costs about 36,000 Baht.	• Create the new mould pallet by following the drawing.	• supervisors in research & development department	• 25/9/06

- **The sixth meeting (The final meeting)**

Date 29/9/06 at 15.00-16.30 Place: Packing Hall meeting room
Participated: Manager in packing department, the supervisors in packing department, the supervisors in research & development department, operators and workers in very shift who work in this line, and Ms. Chollaya

The final meeting report is shown in table 5.6.

Table 5.6: The final meeting report in long set up time project

Topic	Problem/Presentation
1.Conclusion	• Present new cleaning time of each process.
	• Present new ideal production volumes, comparing with production plan volumes.
	• Present the working standard of each cleaning process.
	• Present the economic evaluation of this project, which are detailed in topic 5.2.1

5.1.2 Long freezing time

In long freezing project there are four times of meeting. In the meetings, they also participates with the involved people that are manager to compare project with company's budget, supervisors in packing department to contact a dealer of liquid nitrogen, supervisors in research and development department to develop new equipment for liquid nitrogen usage, supervisor in mixing department who are responsible for production waste, and operator and workers who understand the real situation and problems.

The meeting reports in this project are shown in the following:

- **The first meeting**

Date 2/10/06 at 15.00-16.30 Place: Packing Hall meeting room
Participated: Manager, the supervisors in packing department, the supervisors in research & development department, the supervisors in mixing department, operator and workers, and Ms. Chollaya

The first meeting report is shown in table 5.7.

Table 5.7: The first meeting report in long freezing time project

Topic	Problem / Presentation	Solution	Assign	Finished time
1.Freezing process	• Explain the freezing process in line X.	-	-	-
	• Catch up the problems and freezing time.	• Do why-why analysis to find the root causes of each problem.	• Ms. Chollaya	• 5/10/06

- **The second meeting**

Date 5/10/06 at 15.00-16.30 Place: Packing Hall meeting room
Participated: Manager, the supervisors in packing department, the supervisors in research & development department, the supervisors in mixing department, operator and workers, and Ms. Chollaya

The second meeting report is shown in table 5.8.

Table 5.8: The second meeting report in long freezing time project

Topic	Problem / Presentation	Solution	Assign	Finished time
1.Freezing time	• Show the freezing time. It is a very long time, which is about 30 minutes.	- •	-	-
	• Explain why-why analysis, and apply some improvement techniques to improve this process.	• From why-why analysis, it can conclude that should change freezing agent from salt water to liquid nitrogen	-	-
2.Liquid nitrogen	• Discuss about how to use liquid nitrogen in safety purposed.	• Find characteristics of liquid nitrogen	• Ms. Chollaya	• 7/10/06
		• Contact dealer to know cost and conditions	• supervisors in packing department	• 10/10/06
		• Catch up problems and freezing time when using liquid nitrogen.	• Ms. Chollaya	• 19/10/06

- **The Third meeting**

Date 19/10/06 at 15.00-16.30 Place: Packing Hall meeting room
Participated: Manager, the supervisors in packing department, the supervisors in research & development department, the supervisors in mixing department, operator and workers, and Ms. Chollaya

The third meeting report is shown in table 5.9.

Table 5.9: The third meeting report in long freezing time project

Topic	Problem / Presentation	Solution	Assign	Finished time
1.Liquid nitrogen	• Discuss about the danger of liquid nitrogen usage.	• Since the employees cannot touch it directly, design automatic equipment for dropping liquid nitrogen.	• Ms. Chollaya	• 26/10/06
	• Discuss about the heavy fog which occurs after drop liquid nitrogen in mixed ice-cream	• Design the exhaust pipe to suck that fog. This pipe should link to mixing department, which is responsible for eliminating the production waste.	• Ms. Chollaya	• 26/10/06

- **The fourth meeting (The final meeting)**

Date 26/10/06 at 15.00-16.30 Place: Packing Hall meeting room
Participated: Manager, the supervisors in packing department, the supervisors in research & development department, the supervisors in mixing department, operator and workers, and Ms. Chollaya

The final meeting report is shown in table 5.10.

Table 5.10: The final meeting report in long freezing time project

Topic	Problem / Presentation
1.Liquid nitrogen	• Present new ideal production volumes, comparing with production plan volumes.
	• Present economic evaluation, which is detailed in topic 5.2.2
2.New equipment	• Present the drawing and layout of liquid nitrogen releaser and exhaust pipe.

5.2 Economic evaluation

To get the optimize solution, should study economic evaluation to know which alternative is worth for the investment. One of the most famous evaluation methods is payback period.

Payback period is one of the widely methods. It tells the time to get the investment back from the net profits. Thus, the shorter payback period, the better investment. Payback period is equal to the investment divide by the annual net profits. Since different sums consider in different time, should be calculated by the interest rate.

There are two functions of this method that are incremental and original function. “Incremental function uses for decision making about investment among exclusive alternatives. It will compare the extra cost of an alternative over another to the extra benefit to be received (Steiner, 1996).” For that reason, it always uses for analysis in improvement process like this thesis.

Therefore, to get the optimize solution in this thesis, will be analysed by payback period in incremental function. The calculation in this chapter should use the production plan volumes and interest rate of this year (year 2006) to compare the alternatives.

5.2.1 Set up process

The improved set up processes can reduce an amount of time, so the ideal production volumes will be increased. As a result, the company will solve the unsupported problem. However, for ensuring that it will also be value for investment should be analysed by payback period. Since in this chapter will be calculated by payback period method in incremental function, should analyse the extra investment costs and the extra net profits.

In the set up process, there are seven extra investment costs, shown in table 5.11.

Table 5.11: Investment costs in set up process

Parts	Costs (Baht)
Tool box	600
Table for cleaning	45,000
New vacuum tube	28,000
pH metre	16,000
Pressure equipment for using SU616	10,500
Block screw drivers 4 pieces	720 (180 x 4)
New mould pallet	38,000
Total	**138,820**

The extra net profits include of the increased revenues compare with the additional annual expenses. The additional expenses in this analysis are referred by comparison data between before and after the implementation. The data before the implementation should use the data in year 2005. The after should use the expected data, which have been calculated by the data in September. The extra net profits are detailed in the following:

Since the improved processes reduce set up time about 72.70% of the existing, the company can increase ideal production volumes, shown in table 5.12.

Table 5.12: The ideal production volumes in set up process (Before & after implementation)

Stick X	Ideal production volumes (ML/month)
Before	309.66
After	1587.00

From table 5.12, it can conclude that after implementation, the company can increase ideal production volumes to be 1,587 ML/month, which are calculated by multiplying production hours

per month (328 Hrs.), product's weight (56 DekaLiter, DL) and number of products in each production time (8,640 pieces). Thus, it can support more products, presented in table 5.13.

Table 5.13: The supported product in set up process (Before & after implementation)

Summary 2006													
Stick X (before)	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec	**Total**
Planned Volume (ML)	257	268	403	507	451	410	400	320	328	439	378	356	
Supported product	257	268	310	310	310	310	310	310	310	310	310	310	**3622**
Stick X (after)	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec	**Total**
Planned Volume (ML)	257	268	403	507	451	410	400	320	328	439	378	356	
Supported product	257	268	403	507	451	410	400	320	328	439	378	356	**4517**

From table 5.13, it can conclude that from this year's demand, after the implementation the company can support more products about 24.71%. Therefore, the increased revenue in this year will be detailed in table 5.14.

Table 5.14: The increased revenue in set up process

Type	**Increased volumes (ML/Year)**	**Price/ Unit**	**Increased revenues (Baht/Year)**
Increased support products	895 ML/Year	178.50 Baht/ L (*source: the administration department)	160,000 Million baht/Year (159,757,500,000)
		Total	**160,000 Million baht/Year**

From table 5.14, the increased volumes (895 ML/Year) are calculated by the expected production volumes after the implementation (4,517 ML/Year) minus the actual production volumes before the implementation (3,622 ML/Year). The increased volumes help the company to increase revenues. When increase production volumes to 895 ML/Year, the company can increase revenues approximately 160,000 Million baht/Year. These increased revenues calculate from these increased production volumes (895 ML/Year) multiplied by price per unit (178.50 Baht/L).

Hence, it can conclude that after the implementation the company can increase the production volumes, highly effect to increase revenues. To calculate the net profits, should minus the increased revenue with the extra annual expenses after the implementation. The additional annual expenses are shown in table 5.15.

Table 5.15: The additional annual expenses after the implementation in set up process

Types	Volume	Costs/ Unit (*source: the administration department)	Additional expenses (Baht/Year)
SU 616	850 gal	420 bht/ gal	357,000
TOPEX costs	-5,300,000 m^3	40 bht/m^3	-212,000,000
Hot water costs	16,000,000m^3	75 bht/m^3	1,200,000,000
Electronic costs	-260,000,000 kwh	2.4 bht/kwh	-780,000,000
Wastewater treatment costs	11,000,000 m^3	230 bht/m^3	2,530,000,000
		Total	**2,800 Million baht/Year (2,787,357,000)**

Hence, the net profits of this investment year will be calculated by the increased revenues from table 5.14 minus with the additional annual expenses from table 5.15, shown in table 5.16.

Table 5.16: The net profits in set up process

Types	Costs (Baht/Year)
Incremental revenues of supported product after the implementation	160,000 Million baht/Year
Incremental annual expenses	2,800 Million baht/ Year
Total	**157,200 Million baht/Year**

Therefore, the payback period of this project is shown in the following:

$$\text{Payback} = \frac{\text{Investment costs}}{\text{Net profit}}$$

$$\text{Payback} = \frac{138{,}820 \text{ (Baht)}}{157{,}200 \text{ (Million baht/Year)}}$$

Payback = 27.85 seconds

From the calculation, it is shown that the payback period is so short, so it is worth for investment. However, for getting the right result, should consider about time value. For that reason, should calculate the payback period by means of the interest rate. The interest rate is 7.75% per year. Thus, the payback period should be presented in the following:

$$\text{Payback} = \frac{\text{Investment costs}}{\text{Net profit}}, \; i = 7.75\%$$

$$\text{Payback} = \frac{P}{A} = (P/A, 7.75\%, n)$$

$$\text{Payback} = \frac{138{,}820 \text{ (Baht/Year)}}{157{,}200 \text{ (Million baht/Year)}} = \frac{[(1+0.0775)^n - 1]}{0.0775(1+0.0117)^n}$$

Payback = 28.52 seconds

From that result, it can see that since the improvement can increase the ideal production volumes in a high number, the payback period is very short. Moreover, this line uses the same machine as the other stick lines, so the other machines' utilization will also be increased, shown in table 5.17.

Table 5.17: Every stick ideal production volumes in set up process

Ideal production volumes (ML/Year)	Before	After
Line X	309.66	1587.00
Line Y	281.07	1440.48
Line Z	435.57	2232.28

From table 5.17, it can conclude that after implementation, the company can increase ideal production volumes in every stick line. Hence, the company can support more stick products than the existing, shown in table 5.18.

Table 5.18: Over ideal production volumes after set up process improvement

Summary 2006			Over ideal production volumes									
Stick X	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	257	268	403	507	451	410	400	320	328	439	378	356
Stick Y	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	342	200	199	214	206	213	242	197	197	246	197	197
Stick Z	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	526	531	445	552	460	346	391	391	367	474	422	412
Summary 2007												
Stick X	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	237	211	224	331	234	198	240	206	189	269	218	217
Stick Y	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	212	189	200	297	209	177	215	185	169	241	196	194
Stick Z	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	379	338	358	531	375	317	384	330	303	432	350	348
Summary 2008												
Stick X	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	620	553	585	867	612	517	627	540	495	705	572	568
Stick Y	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	220	197	208	308	218	184	223	192	176	251	203	202
Stick Z	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	407	363	384	569	402	340	412	354	325	463	375	373

From table 5.18, it can conclude that these improved processes can increase ideal production volumes in a high number, so the company can support not only this year's production plan volumes but also the forecasting years'. Therefore, although these improved processes have to spend on an amount of money, they also return the investment very soon. For that reason, it can conclude that this project is the worth project for investment.

Moreover, this project also reduces an amount of manufacturing cost, which is detailed in the following. Since the company sets the profit of each product about 20% of the net costs, the manufacturing costs before the implement are about 148.75 Baht/L. About 10% of these manufacturing costs are raw material costs, about 15 Baht/L. Therefore, the manufacturing costs before the implement is shown in table 5.19.

Table 5.19: The manufacturing costs before the implement in set up processu

Type	Actual production volume (ML/Year)	Costs/ Unit	Manufacturing costs (Baht/Year)
Manufacturing costs before the implement	3622 ML/Year	148.75 Baht/ L (*source: the administration department)	539,000 Million baht/Year (538,772,500,000)
		Total	**539,000 Million baht/Year**

From table 5.19, it can conclude that after the implement the company has to increase some of annual expenses. Moreover, it also increases the raw material costs. However, all of these costs are only very small number, because the machine can produce much more products. Thus, the company can reduce an amount of manufacturing costs, shown in table 5.21.

Table 5.20: The reduced manufacturing costs after the implement in set up process

Type	Expected production volume (ML/Year)	Costs/ Unit	Manufacturing costs (Baht/Year)
Manufacturing costs before the implement	3622 ML/Year	148.75 Baht/ L (From table 5.13)	539,000 Million baht/Year (538,772,500,000)
Additional raw material costs	895 ML/Year (From table 5.13)	15 Baht/L	13,000 Million baht/Year (13,425,000,000)
Additional annual exprenses (From table 5.15)			2,800 Million baht/Year (2,787,357,000)
Total manufacturing costs after the implementation	**4517 ML/Year**	**122.82 Baht/L**	**554,800Million baht/Year (554,984,857,000)**

From table 5.20, the manufacturing costs after the implementation (554,800Million baht/Year) are calculated by combining the manufacturing costs before the implementation (539,000 Million baht/Year) and increased costs (15,800 Million baht/Year). These increased costs come from the increased raw material costs (13,000 Million baht/Year) and increased annual expenses (2,800 Million baht/Year) combination. As a result, it can conclude that the manufacturing costs after implementation per unit (L) are approximately 122.82 Baht/L or 123 Baht/L.

For that reason, after the implementation the company can reduce the manufacturing costs from 148.75 Baht/L to 123 Baht/L, which is about 17.31%. As a result, set up process implementation is not only helps the company to support more product, which increase revenues, but also reduce an amount of manufacturing costs. Consequently, should invest in this project.

5.2.2 Freezing process

Since liquid nitrogen can freeze the mixed ice-cream in shorten time, it can speed up machine's production stroke. It will speed up from 16 strokes per minute to 21 strokes per minute or can produce more products from 160 pieces per minute to 210 pieces per minute. For that reason, it can assume that it can increase ideal production volumes.

Therefore, for decision making to choose the optimize solution, should use payback period in incremental function. To calculate, should know two important cash that are the extra investment costs and the additional annual net profits.

All of the extra investment costs in this project are machine costs that are the costs of liquid nitrogen releaser, new motor to support every connected arm, and an exhaust pipe. The investment costs are shown in table 5.21.

Table 5.21: Investment costs in freezing process

Parts	Costs (Baht)
Exhaust pipe	110,000
Liquid nitrogen releaser	62,000
New motor	12,000
Total	**184,000**

The added annual net profits will be calculated the same as in the set up process that is calculated by the increased revenue and extra annual expenses. The additional annual expenses will compare the data between before and after the implementation. The data before the implementation also uses the data in year 2005. The after should use the expected data, which have been calculated by the data in October. Since liquid nitrogen helps to speed up machine's production stroke, it will increase ideal production volumes, shown in table 5.22.

Table 5.22: The ideal production volumes in freezing process (Before & after implementation)

Stick X	Ideal production volumes (ML/Year)
Before	309.66
After	406.43

From table 5.22, it can conclude that the ideal production volumes increase about 96.77 ML/month that is to be 406.43 ML/Year. This new ideal production volumes are calculated by multiplying production hours per month (64 Hrs.), product's weight (56 Dekaliter, DL) and number of products in each production time (11,340 pieces). As a result, the company will support more products, shown in table 5.23.

Table 5.23: The supported product in freezing process (Before & after implementation)

Summary 2006													
Stick X (before)	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec	Total
Demand Volume (ML)	257	268	403	507	451	410	400	320	328	439	378	356	
Supported product	257	268	310	310	310	310	310	310	310	310	310	310	3622
Stick X (after)	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec	Total
Demand Volume (ML)	257	268	403	507	451	410	400	320	328	439	378	356	
Supported product	257	268	310	406	406	406	400	320	328	406	378	356	4241

From table 5.23, it can conclude that although it can support more products, there are still unsupported products especially in peak periods. As a result, it can assume that liquid nitrogen cannot increase ideal production volumes enough for supporting production plan volumes. However, the revenue still increases, shown in table 5.24.

Table 5.24: The increased revenue in freezing process

Type	**Increased volume (ML/Year)**	**Price/ Unit**	**Increased revenues (Baht/Year)**
Increased support products	619 ML	178.50 Baht/ L (*source: the administration department)	110,000 Million baht/Year (110,049,150,000)
		Total	**110,000 Million baht/Year**

From table 5.24, it can conclude that after implementation the revenue will be increased roughly 110,000 Million baht/Year. This increased revenue is calculated by multiplying the increased volume (619 ML/Year) and price/unit. The increased volume comes from the expected production volumes after the implementation (4,241 ML/Year) minus the actual production volumes before the implementation (3,622 ML/Year).

However, to calculate the net profits, should minus this increased revenue with the additional annual expenses.

The supplementary annual expenses will include of the liquid nitrogen and the electric costs. For freezing process, have to drop liquid nitrogen in one droplet, which is about 20 ml, for each mould. The additional annual expenses are shown in table 5.25.

Table 5.25: The additional annual expenses after the implementation in freezing process

Types	**Volume**	**Costs/ Unit** (*source: the administration department)	**Costs (Baht/Year)**
Liquid nitrogen	2,950,000 kg	4 Baht/ kg	11,800,000
Electronic costs	4,100,000 kwh	3 Baht/kwh	12,300,000
		Total	**24 Million baht/Year (24,100,000)**

The net profits are calculated by the increased revenue from table 5.24, and extra annual expenses from table 5.25, shown in table 5.26.

Table 5.26: The net profits in freezing process

Types	**Costs (Baht)**
Incremental revenues of supported product after the implementation	110,000 Million baht/Year
Incremental annual expenses	24 Million baht/Year
Total	**109,976 Million baht/Year**

After all, calculate the payback period in incremental function by using investment costs from table 5.21 and net profits from table 5.26. The payback analysis is shown in the following:

$$\text{Payback} = \frac{\text{Investment costs}}{\text{Net profit}}$$

$$\text{Payback} = \frac{184{,}000 \text{ (Baht)}}{109{,}976 \text{ (Million baht/Year)}}$$

Payback = 52.76 seconds

From the calculation, it can see that the payback period is very short. However, for getting the reliable payback period, should consider about time value. Therefore, should calculate by means of interest rate. The interest rate is 7.75% per year. The reliable payback period is shown in the following:

$$\text{Payback} = \frac{\text{Investment costs}}{\text{Net profit}}, \; i = 7.75\%$$

$$\text{Payback} = \frac{P}{A} = (P/A, 7.75\%, n)$$

$$\text{Payback} = \frac{184{,}000 \text{ (Baht/Year)}}{109{,}976 \text{ (Million baht/Year)}} = \frac{[(1+0.0775)^n - 1]}{0.0775(1+0.0117)^n}$$

Payback = 56.89 seconds

From the result, it is shown that the payback period in this project is also very short, so it can assume that it is also worth for investment. Moreover, since all of the stick lines use the same machine, the other machines' utilization will also be increased, shown in table 5.27.

Table 5.27: Every stick ideal production volumes in freezing process

Ideal production volumes (ML/Year)	Before	After
Line X	309.66	406.43
Line Y	281.07	368.90
Line Z	435.57	571.68

From table 5.27, it can conclude that all of the stick's ideal production volumes are increasing, so they will support more products, shown in table 5.28.

Table 5.28: Over ideal production volume after freezing process improvement

Summary 2006			Over ideal production volumes									
Stick X	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	257	268	403	507	451	410	400	320	328	439	378	356
Stick Y	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	342	200	199	214	206	213	242	197	197	246	197	197
Stick Z	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	526	531	445	552	460	346	391	391	367	474	422	412
Summary 2007												
Stick X	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	237	211	224	331	234	198	240	206	189	269	218	217
Stick Y	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	212	189	200	297	209	177	215	185	169	241	196	194
Stick Z	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	379	338	358	531	375	317	384	330	303	432	350	348
Summary 2008												
Stick X	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	620	553	585	867	612	517	627	540	495	705	572	568
Stick Y	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	220	197	208	308	218	184	223	192	176	251	203	202
Stick Z	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec
Production plan volume (ML)	407	363	384	569	402	340	412	354	325	463	375	373

From table 5.28, it can conclude that although the payback period in this project is very short, there are still the unsupported products obviously in forecasting year (year 2008). For that reason, it can assume that this project is not a optimize solution, because it cannot eliminate the critical problem definitely.

Hence, the company should invest in only the set up process improvement project, which is not only has short payback period but also can get rid of the critical problem completely. Therefore, after implementation the company will support enough products for customers' requirement, which is the important factor to get customers' satisfaction and more market share.

CHAPTER VI

RESULTS AND TECHNICAL EVALUATION

6.1 Results and Technical evaluation

From the outcome in chapter 5, it can conclude that the company should invest only in changeover project. The results and technical evaluation in this project are detailed in the following:

1. Arrange mould by number

When remove moulds, the operator and workers should separate the odd and even numbers in the different side of the pallet. Moreover, all of those moulds should be arranged by number. As a result, it will be much easier for sealing mould in the next time.

2. The fin of each mould is not straight

This problem comes from the unproductive mould storage, so the top mould's weight presses the bottom. Thus, should design the new mould pallet. There are two drawing sketches for solving this problem that are the hook one and the partition one.

Although both of them can separate each mould, there are some differences. Each of them has the different advantages and disadvantages. For using the partition one, there are some problems that are the stored moulds can fail at the side when the mould pallet is moved to the machine. Moreover, it still has the mould's weight problem, because the fin of the bottom side will be not straight.

On the other hand, the hook one will be more expensive, but it will not occur those serious problems. For that reason, the involved staffs choose the hook mould pallet to be the new one.

This hook mould pallet is made of stainless steel grade 316, which is the widely used material in food manufacturer. However, to work more conveniently should produce two pallets to separate the odd and even numbers, shown in figure 6.1.

Figure 6.1: New mould pallet

3. Taking a long time in removing hot water and TOPEX in cleaning mould process

The cause of this problem comes from the bottle neck, which is at the bottom of the vacuum tubes. Since there is some stuck dirt in the bottle neck, the tubes takes a long time to suck all of liquid in mould. Therefore, for sucking much quicker, eliminate that bottle neck. As a result, the new ones can suck all of liquid in the first time. The new vacuum tubes are shown in figure 6.2.

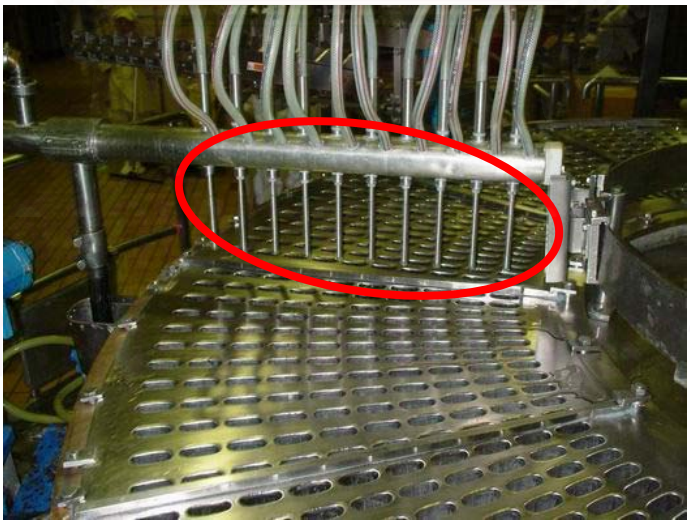


Figure 6.2: New vacuum tube

4. Using SU 616

SU 616 always uses in the food industry. However, for ensuring that it is suitable for cleaning in ice-cream industry should test with the HACCP standard. The HACCP standard of this manufacturer are checking the vital three types of micro-organism, which can stay in the cool condition, that are SPC to be not more that 70 CFU/ml, Colifoam to be 10 CFU/ml or below and E. coli to be not more than 10 CFU/ 25 cm^2, shown in the table 6.1.

Table 6.1: Microbial testing when using SU 616

Part	SPC (CFU/ml)	Coliform (CFU/ml)	E.coli (CFU/25cm^2)
1. Arm	<10	<10	<10
2. Filler Sauce	<10	<10	<10
3. Mould	<10	10	<10
4. Hopper	<10	<10	<10
5. Tank	<10	<10	<10

From table 6.1, it can conclude that SU 616 can clean in ice-cream industry, because the microbial testing is in HACCP standard.

5. Tool box and chart

At the present time, the company keeps instrument in the tool tray, which is unordered. Therefore, it is very difficult to find the tool, and always has the tool loss problem. For that reason, generate the tool box, which is applied by 5S technique. As a result, this tool box is order the most frequency tool to be the accessible place, shown in figure 6.3.

Figure 6.3: Tool box

Moreover, also generate the tool chart, which will attach with the tool box, shown in table 6.2. This tool chart will record the borrowing data, so it can solve the tool loss problem.

Table 6.2: Tool chart

Tool	Amount	(Name) Line	(Name) Line	(Name) Line	Borrower	Borrow Date	Borrow Time	Return

6. Screwdrivers

In this line, it uses a number of bolts and nuts that are about 48 pieces for holding mould with machine. For that reason, it takes an amount of time for sealing and removing mould, so should use some helpful tool such as block screwdrivers or air screwdrivers.

In the meeting, it is found that the air screwdriver is not a useful tool especially in the long period, because the bolts and nuts will be eroded earlier than the usual. Hence, should use block

screw driver, which is not only help the workers to do their jobs much easier but also do not wear away the bolts and nuts. Using the block screwdriver is shown in figure 6.4.

Figure 6.4: Block screwdriver

7. pH metre

The cleaning agent should be changed from detergent to SU 616, which is a strong alkaline. Thus, for ensuring that there is no alkaline left behind in the end- products should check pH value to be 7 - 8. Nowadays, the company is checked by litmus paper, which is difficult to read. Hence, maybe get the wrong answer. Moreover, only skilled employees can use it.

For that reason, should use the electronic equipment to help that is pH metre. This metre is not only can read pH value more correctly but also easy to use. Hence, every employee can use it. The pH metre is shown in figure 6.5.

Figure 6.5: pH metre

8. Table for cleaning

Since the employees do not have the suitable utensil for cleaning small equipment, there are some ineffective cleaning behaviours. These bad behaviours effect to workers' physic, and their psychology. From that reason, the worker work worse than the common.

As the result, should create the table for cleaning, which is designed by ergonomic theory. Therefore, the workers will not get any physical problems, so they will do their jobs more effectively. The table for cleaning is shown in figure 6.6.

Figure 6.6: Table for cleaning

9. O-ring keeper

In this line, it uses many sizes of o-ring, but do not have the suitable utilize for separate them during cleaning process. Therefore, the workers should take a long time to trial the correct o-ring with the right equipment.

Consequently, in the meeting, there are two drawings of o-ring keeper. Both of them can separate o-rings size during cleaning process, and also made of the available material. Hence, the company does not spend any extra money. However, the staffs choose the ring one, because it can clean o-ring much easier. The o-ring keeper is shown in figure 6.7.

Figure 6.7: O-ring keeper

10. Rearranged work

From previous idea, which is applied by improvement technique, it can conclude that this technique help the company to work faster and easier. However, to work more effectively, should allocate resource and time to be more efficient. As a result, it will reduce an amount of time, and the unnecessary tasks such as transportation and delay. The flowcharts of each cleaning process are shown in the following.

Besides, to ensure that these improved processes can use in the actual situation should do the microbial testing in HACCP process. This testing will assure that those processes will not left the micro-organism in the end- products, which the customers concern. The microbial tests of each cleaning process are presented in the following:

- *Cleaning process when using machine 90 minutes in original pattern*

This type of cleaning process takes the shortest time that is about 5.28 Hrs.. After the resource and time allocation, it can reduce an amount of time to be about 1.38 Hrs. Moreover, it also eliminates unnecessary tasks, and task time. For that reason, the employees can work more effectively. However, because of killing microbial there are still ineffective works such as waiting for boiling and soaking equipment. The flow process chart of this cleaning process is shown in table 6.3.

Table 6.3: Flow process chart of cleaning process when using machine 90 minutes in original pattern (after implementation)

Flow Process Chart								
Activity: Changing process when using machine 90 minutes in origianl pattern (after implementation)			Summary					
			Activity				Numbers of steps	
			Operation				13	
			Transporation				6	
			Delay				6	
			Inspection				0	
			Store				0	
Describe	QYT (People)	Time (Mins)	Symbol					
Operator								
1.cleaning freezer	1	10						
2. go to get the next raw material	1	10						
3. waiting for the next raw material	1	15						
4. receive the next raw material	1	10						
5. move to the machine	1	10						
6. cleaning mould by foam	1	6						
7. waiting for foam	1	15						
8. removing foam	1	35						
Assistant								
1. cleaning old mixed in mould	1	30						
2. move to get vacuum tube	1	15						
3. cleaning arm and wrapper	1	10						
4. cleaning conveyor	1	10						
5. waiting for boiling in filler & hopper	1	10						
6. move the equipment to soak TOPEX	1	15						
7. waiting for soaking TOPEX	1	15						
8.assembly filler & hopper	1	11						
Workers 1,2,3 & 4								
1.remove filler & hopper	2	38						
2.cleaning filler & hopper	3	16						
3. move equipment to the boiler	2	10						
4. setting the boiler	1	10						
5. waiting for boiling	4	10						
6. move the equipment to soak TOPEX	4	15						
7. waiting for soaking TOPEX	4	15						
8. cleaning stick inserter	1	40						
9.assembly filler & hopper	4	11						

From table 6.3, it can conclude that the improved process can reduce an amount of task time, and a number of ineffective tasks. Nevertheless, for ensuring that the improved process does not poison in the end- products when using in the real situation should be check by the microbial testing in HACCP process, show in table 6.4.

Table 6.4: Microbial Test of cleaning process when using machine 90 minutes in original pattern (after implementation)

Part	SPC (CFU/ml)	Coliform (CFU/ml)	E.coli (CFU/25cm^2)
1. Arm	<10	<10	<10
2. Filler Sauce	<10	<10	<10
3. Mould	<10	<10	<10
4. Hopper	<10	<10	<10

From table 6.4, it can conclude that this improved process passes the HACCP standard, so it does not poison in the end- products when applying in the real condition. Therefore, this improved process is the effective process, because it is not only reduces waste time and unnecessary tasks but also does not get the food poisoning.

- *Cleaning process when using machine 90 minutes in mixed chocolate pattern*

After improve the process by using advance technique, it can reduce set up time from 6.07 Hrs. to 2.05 Hrs. Furthermore, it also can reduce ineffective tasks and task time. However, like the previous process, it still has some of the ineffective works for hygiene purposed. The flow process chart of this process is shown in table 6.5.

Table 6.5: Flow process chart of cleaning process when using machine 90 minutes in mixed chocolate pattern (after implementation)

Flow Process Chart								
Activity: Changing process when using machine 90 minutes in mixed chocolate pattern (after implementation)			Summary					
			Activity			Numbers of steps		
			Operation			15		
			Transporation			6		
			Delay			6		
			Inspection			0		
			Store			0		
Describe	QYT (People)	Time (Mins)	Symbol					
Operator								
1.cleaning freezer	1	10						
2. go to get the next raw material	1	10						
3. waiting for the next raw material	1	15						
4. receive the next raw material	1	10						
5. move to the machine	1	10						
6. cleaning mould by foam	1	6						
7. cleaning tank by foam	1	6						
8. waiting for foam	1	15						
9. removing foam	1	35						
Assistant								
1. cleaning old mixed in mould	1	30						
2. move to get vacuum tube	1	15						
3. cleaning arm and wrapper	1	10						
4. cleaning conveyor	1	10						
5. waiting for boiling in filler & hopper	1	10						
6. move the equipment to soak TOPEX	1	15						
7. waiting for soaking TOPEX	1	15						
8.assembly filler & hopper	1	11						
Workers 1,2,3 & 4								
1. remove old mixed in tank	1	45						
2.remove filler & hopper	2	38						
3.cleaning filler & hopper	3	16						
4. move equipment to the boiler	2	10						
5. setting the boiler	1	10						
6. waiting for boiling	4	10						
7. move the equipment to soak TOPEX	4	15						
8. waiting for soaking TOPEX	4	15						
9. cleaning stick inserter	1	40						
10.assembly filler & hopper	4	11						

In food or ice-cream business, microbial testing is one of the most important processes. It can assure that there is not food poisoning in the end-products. Hence, for the hygiene purposed, should have the microbial testing to be in the HACCP standard, show in table 6.6.

Table 6.6: Microbial Test of cleaning process when using machine 90 minutes in mixed chocolate pattern (after implementation)

Part	SPC (CFU/ml)	Coliform (CFU/ml)	E.coli (CFU/25cm^2)
1. Arm	<10	<10	<10
2. Filler Sauce	<10	<10	<10
3. Mould	<10	<10	<10
4. Hopper	<10	<10	<10
5. Tank	<10	<10	<10

From table 6.6, it can conclude that this process passes the HACCP standard, so it will not poison in the end- products. Thus, it can be applied in the actual process.

- *Cleaning process when changing product from original pattern to original pattern*

The improved process applies not only useful technique but also some professional instrument. For that reason, it can reduce the set up time from 7.00 Hrs. to be 2.45 Hrs.. Besides, it also reduces some ineffective tasks and task time like the others. The flow process chart of this process is shown in table 6.7.

Table 6.7: Flow process chart of cleaning process when changing product from original pattern to original pattern (after implementation)

Flow Process Chart								
Activity: Changing process from original pattern to original pattern (after implementation)			Summary					
			Activity			Numbers of steps		
			Operation			18		
			Transporation			5		
			Delay			4		
			Inspection			0		
			Store			0		
Activity: Changing from original pattern to original pattern (after implementation)								
	QYT	Time	Symbol					
Describe	(People)	(Mins)	○	⇨	D	□	▽	
Operator								
1.cleaning freezer	1	10						
2. cleaning old mixed in mould by foam	1	12						
3.remove mould	1	57						
4. go to get the next raw material	1	10						
5. waiting for the next raw material	1	15						
6. receive the next raw material	1	10						
7. move to the machine	1	10						
8.seal mould	1	26						
9. cleaning mould by foam	1	6						
10. waiting for foam	1	15						
11. removing foam	1	10						
Assistant								
1.remove mould	1	57						
2. move to get vacuum tube	1	15						
3. cleaning arm and wrapper	1	30						
4. cleaning conveyor	1	10						
5.seal mould	1	26						
Workers 1,2,3 & 4								
1.remove filler & hopper	1	38						
2.cleaning filler & hopper	3	16						
3. move equipment to the boiler	3	10						
4. setting the boiler	1	10						
5. waiting for boiling	3	10						
6. move the equipment to soak TOPEX	3	15						
7. waiting for soaking TOPEX	3	15						
8. cleaning stick inserter	1	40						
9.assembly filler & hopper	3	15						
2.remove mould	2	57						
3.seal mould	2	26						

From table 6.7, it can conclude that this improved process is an effective process, because it reduces not only an amount of task time but also a number of ineffective jobs. However, resource and time allocations are not enough for the food industry. Since it has to be responsible for customers' health, it should concern about the food safety too. For that reason, should check the microbial testing by following the HACCP standard, shown in table 6.8.

Table 6.8: Microbial Test when changing product from original pattern to original pattern (after implementation)

Part	SPC (CFU/ml)	Coliform (CFU/ml)	E.coli (CFU/25cm^2)
1. Arm	<10	<10	<10
2. Filler Sauce	<10	<10	<10
3. Mould	<10	<10	<10
4. Hopper	<10	<10	<10

From table 6.8, it can conclude that since it passes all of the microbial standards, it can assure that this improved process does not poison in the end- products. As a result, it can be applied in the real process.

- *Cleaning process when changing product from original pattern to mixed chocolate pattern*

This improved process is applied by ECRS technique, and powerful device. Therefore, after the improvement, it can reduce the set up time from 8.06 Hrs. to be only 3.15 Hrs. Moreover, it can reduce not only an amount of set up time but also a number of ineffective tasks, shown in table 6.9.

Table 6.9: Flow process chart of cleaning process when changing product from original pattern to mixed chocolate pattern (after implementation)

Flow Process Chart								
Activity: Changing process from original pattern to mixed chocolate pattern (after implementation)			Summary					
			Activity		Numbers of steps			
			Operation	○	21			
			Transporation	⇨	6			
			Delay	D	4			
			Inspection	□	0			
			Store	▽	0			
Describe	QYT (People)	Time (Mins)	Symbol ○	⇨	D	□	▽	
Operator								
1.cleaning freezer	1	10						
2.remove mould	1	57						
3. go to get the next raw material	1	10						
4. waiting for the next raw material	1	15						
5. receive the next raw material	1	10						
6. move to the machine	1	10						
7.seal mould	1	26						
8. cleaning mould by foam	1	6						
9. cleaning tank by foam	1	6						
10. waiting for foam	1	15						
11. removing foam	1	35						
12. assembly of tank	1	20						
Assistant								
1.remove mould	1	57						
2.move to get vacuum tube	1	15						
3.seal mould	1	26						
4. cleaning arm and wrapper	1	30						
5. cleaning conveyor	1	10						
Workers 1, 2, 3 & 4								
1. cleaning old mixed in mould by foam	2	12						
2.go to get tank from storage	1	15						
3. remove old mixed in tank	1	45						
4.cleaning mould on machine by foam	2	42						
5.remove mould	2	57						
6.seal mould	2	28						
7.remove filler & hopper	1	38						
8.cleaning filler & hopper	3	16						
9. move equipment to the boiler	3	10						
10. setting the boiler	1	10						
11. waiting for boiling equipment	3	10						
12. move the equipment to soak TOPEX	3	15						
13. waiting for soaking TOPEX	3	15						
14. cleaning stick inserter	1	40						

From table 6.9, it can conclude that this improved process can reduce an amount of task time and a number of ineffective tasks. However, for ensuring that it has a food safety should do the microbial test by following the HACCP standard. The microbial test in this process is shown in table 6.10.

Table 6.10: Microbial Test when changing product from original pattern to mixed chocolate pattern (after implementation)

Part	SPC (CFU/ml)	Coliform (CFU/ml)	E.coli (CFU/25cm^2)
1. Arm	<10	<10	<10
2. Filler Sauce	<10	<10	<10
3. Mould	<10	<10	<10
4. Hopper	<10	<10	<10
5. Tank	<10	<10	<10

From table 6.10, it can conclude that from hygiene concern, this process passes the HACCP standard. Thus, it can be applied in the actual process.

- *Cleaning process when changing product from mixed chocolate pattern to mixed chocolate pattern*

This is the last type of cleaning process. In general, it takes the longest set up time that is about 8.07 Hrs.. After the improvement by using powerful technique and equipment, it can reduce to be only 3.12 Hrs.. It is not only reduces a set up time but also reduce the ineffective tasks and task time too. Its flow process chart is shown in table 6.11.

Table 6.11: Flow process chart of cleaning process when changing product from mixed chocolate pattern to mixed chocolate pattern (after implementation)

Flow Process Chart								
Activity: Changing process from mixed chocolate pattern to mixed chocolatepattern (after implementation)			Summary					
			Activity		Numbers of steps			
			Operation		19			
			Transporation		5			
			Delay		4			
			Inspection		0			
			Store		0			
Describe	QYT (People)	Time (Mins)	Symbol					
Operator								
1.cleaning freezer	1	10						
2.remove mould	1	57						
3. go to get the next raw material	1	10						
4. waiting for the next raw material	1	15						
5. receive the next raw material	1	10						
6. move to the machine	1	10						
7.seal mould	1	26						
8. cleaning mould by foam	1	6						
9. cleaning tank by foam	1	6						
10. waiting for foam	1	15						
11. removing foam	1	35						
12. assembly of tank	1	20						
Assistant								
1.remove mould	1	57						
2.move to get vacuum tube	1	15						
3.seal mould	1	26						
4. cleaning arm and wrapper	1	30						
5. cleaning conveyor	1	10						
Workers 1, 2, 3 & 4								
1. cleaning old mixed in mould by foam	2	12						
2. remove old mixed in tank	1	45						
3.remove filler & hopper	1	38						
4.cleaning filler & hopper	3	16						
5. move equipment to the boiler	3	10						
6. setting the boiler	1	10						
7. waiting for boiling equipment	3	10						
8. move the equipment to soak TOPEX	3	15						
9. waiting for soaking TOPEX	3	15						
10.assembly filler	3	15						
11. cleaning stick inserter	1	40						

From table 6.11, it can conclude that the improved process can reduce an amount of task time and ineffective tasks. However, it still has some of them because of food safety purpose. Furthermore, to ensure that this improved process will not get the food poisoning should do the microbial testing by following the HACCP system. The microbial testing is shown in table 6.12.

Table 6.12: Microbial Test when changing product from mixed chocolate pattern to mixed chocolate pattern (after implementation)

Part	SPC (CFU/ml)	Coliform (CFU/ml)	E.coli (CFU/25cm^2)
1. Arm	<10	<10	<10
2. Filler Sauce	<10	<10	<10
3. Mould	<10	<10	<10
4. Hopper	<10	<10	<10
5. Tank	50	<10	<10

From table 6.12, it can be seen that the result of tank testing has high amount of SPC; however, it is still in the standard. For that reason, it can conclude that the results of microbial testing are the same as the others that is in the HACCP standard. Therefore, it also can be applied in the real condition like the others too.

Consequently, it can conclude that after the improvement by the ECRS technique, the improved cleaning processes can reduce not only an amount of task time but also a number of ineffective tasks. For these resource and time allocations, the company can reduce the set up time in every process, shown in figure 6.8 and table 6.13.

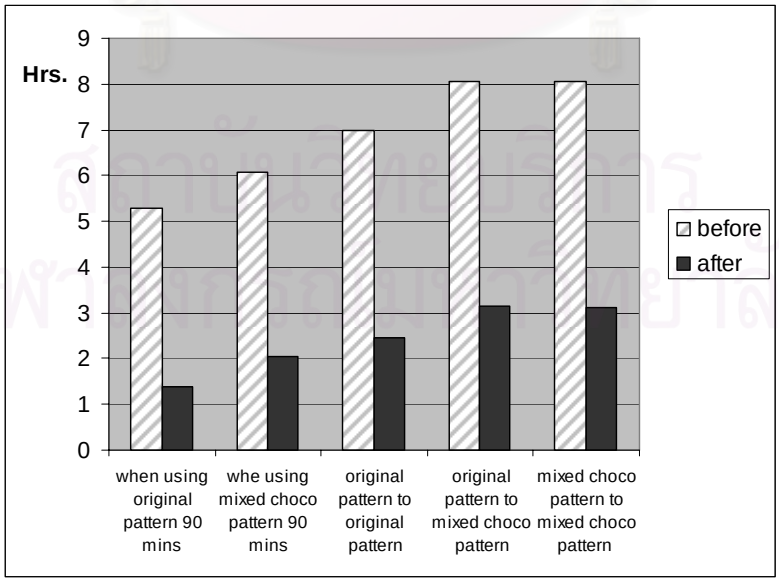


Figure 6.8: Changing time before and after implementation

Table 6.13: Changing time before and after implementation

Type	Before	After	Decreased
1. When producing original pattern in 90 minutes	5.28	1.38	3.90
2. When producing mix chocolate pattern in 90 minutes	6.07	2.05	4.02
3. Change product from original pattern to original pattern	7.00	2.45	4.55
4. Change product from original pattern to mix chocolate pattern	8.06	3.15	4.91
5. Change product from mix chocolate pattern to mix chocolate pattern	8.07	3.12	4.95
Average	6.90	2.43	4.47 or 64.78%

From figure 6.8 and table 6.13, it can conclude that after the implementation, set up time can reduce from the average 6.90 Hrs. to average 2.43 Hrs or about 64.78% of set up time before implementation. Since set up time is the main production time loss, these reductions are highly effect to increase the production time. Therefore, it will help to increase the ideal production volumes.

CHAPTER VII

CONCLUSION AND RECOMMENDATION

7.1 Conclusion

Since the competitive pressure in nowadays' situation is increasing, every company has to develop their manufacturing performance to get higher market share and profits obviously in the ice-cream business.

The most important factor to get more market position in ice-cream business is customers' satisfaction, so every ice-cream manufacturer concerns about supporting all of the customers' demands. Therefore, in this thesis, should focus on improve production process to support customers' requirement.

A case study, used in this thesis, is the huge and famous ice-cream factory. It supports products not only for domestic market but also for international market. Since both of these markets are increasing every year, there is an unsupported product problem. For that reason, the company will lose not only an amount of expected revenues but also lose the customers' satisfaction. As a result, it will lose the market position to its competitors.

Therefore, in this thesis, will increase ideal production volumes by minimizing the lose time in production process especially in set up process and freezing process. All of these processes take an amount of time. To minimize these time, should apply ECRS technique, including develop equipment and procedures. Furthermore, to solve the problem more effectively, will concentrate on the most critical line that is in the stick line.

To achieve the thesis objective, should record and understand the involved data in correct methodology. After that, analyse all of those data by why-why analysis to get the root causes. Then, plan for eliminate all of these root causes to assure that the problems will not occur again. In this thesis, there are two improvement projects that are set up project and freezing project. Therefore, should do economic evaluation to choose the optimize project. Finally, implement that optimize project, and do technical evaluation to assure that this project can use in the actual situation.

In set up process, after consider on the why-why analysis, it can conclude that there are a number of unnecessary procedures such as transportation and waiting. All of these tasks waste an amount of time. Moreover, ice-cream has support factors for microbial to generate such as protein from milk, sugar, and humid. Hence, for food safety, the company should clean machine in every 90 minutes and when changing product.

Therefore, in planning process, should use ECRS technique to improve all of these causes. For that reason, the cleaning processes will reduce a number of unnecessary procedures especially in the critical parts such as tank and mould. However, for hygiene purpose, there are still few of them such as waiting for boiling and soaking equipment. As a result, all of the improved processes can reduce set up time, which effect to increase ideal production volumes.

Besides, from why-why analysis in the freezing process, it can conclude that it uses an unsuitable freezing agent that is salt water. Hence, it takes a very long time in freezing process. There are two main reasons. The first one is it takes an amount of time for mixing in the appropriate rate. This rate depends on the room temperature, so it has to change all the time to get the specific point. The other one is salt water takes an amount of time to transfer the heat with the mixed ice-cream.

After plan this project, it can conclude that should change the freezing agent to liquid nitrogen, which is widely used in ice-cream business. For using liquid nitrogen, should drop it in 20 ml droplet into each mould. It will freeze the mixed ice-cream in very short time. Moreover, its freezing point is constant, so it can get the specific shape in the shorten time too.

For that reason, it can reduce an amount of freezing time, so it will effect to speed up the production stroke. It can speed up machine stroke from 16 stroke per minute to 21 stroke per minute or can produce 160 pieces per minute to 210 pieces per minute. As a result, ideal production volumes will also be increased.

However, liquid nitrogen also has the disadvantages. It can burn employees' hands if they touch it directly. Thus, should design an automatic system, linking with the machine stroke. Another is after drop it in mould it will produce a heavy fog on the top of machine. This fog is not dangerous to the operator but it will effect to operate the machine. Consequently, should design the exhaust pipe, which sets up nearby the operating area. This pipe will suck all of the fog to the mixing department, which is responsible for eliminating production waste.

After plan these improvement projects, should make the decision by using the economic evaluation to get the worth project. In this thesis, use payback period method. Payback can tell the time when investment will pay back from the net profits. Thus, the shorter payback period, the better investment.

From the evaluation, both of these projects have very short payback period. Nevertheless, the freezing process increases ideal production volumes in a small number, which still cannot support to production plan volumes. For that reason, there is still unsupported problem obviously in the peak periods. On the other hand, in the set up process, it increases ideal production volumes in higher number. Therefore, it is not only support production plan volumes in this year but also in the forecasting years. As a result, the company invests only in changeover project.

After the implementation of the changeover project, the improved processes can reduce a number of unnecessary procedures, shown in table 7.1.

Table 7.1: Unnecessary procedures (Before & after implementation)

Process	Symbol	Before	After
1.Changing process when using machine 90 minutes	○	16	13
in origianl pattern	⇨	8	6
	D	3	6
	□	0	0
	▽	0	0
2.Changing process when using machine 90 minutes	○	19	15
in mixed chocolate pattern	⇨	8	6
	D	4	6
	□	0	0
	▽	0	0
3.Changing process from original pattern	○	24	18
to original pattern	⇨	7	5
	D	4	4
	□	0	0
	▽	0	0
4.Changing process from original pattern	○	27	21
to mixed chocolate pattern	⇨	7	6
	D	5	4
	□	0	0
	▽	0	0
5. Changing process from mixed chocolate pattern to	○	23	19
mixed chocolatepattern	⇨	8	5
	D	5	4
	□	0	0
	▽	0	0

Moreover, all of these processes also apply some helpful instrument, so it can reduce an amount of set up time that is about 64.78% of before implementation. As a result, the company can reduce an amount of production time loss, shown in figure 7.1.

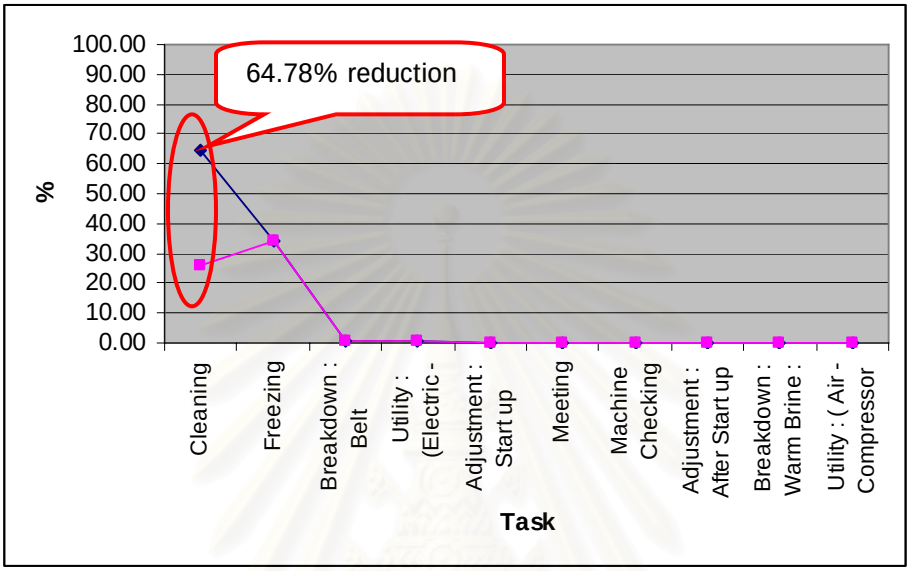


Figure 7.1: Production time loss (Before & after implementation)

From figure 7.1, it can conclude that after the implementation the cleaning time loss can from 6.90 hrs per production cycle to 2.43 hrs per production cycle or about 64.78%, which effect to increase ideal production volumes, shown in table 7.2.

Table 7.2: Ideal production volumes (Before and after the implementation)

Ideal production volumes (ML/month)	Before	After	Increased
Line X	309.66	1587.00	1277.34
Line Y	281.07	1440.48	1159.41
Line Z	435.57	2232.28	1796.71
Average	342.10	1753.25	1411.15 or 5.12 times

From table 7.2, it can conclude that after the implementation, the company can increase ideal production volumes from 342.10 ML/month to 1753.25 ML/month or roughly 5 times. The increased ideal production volumes will delete the unsupported production problem, shown in figure 7.2.

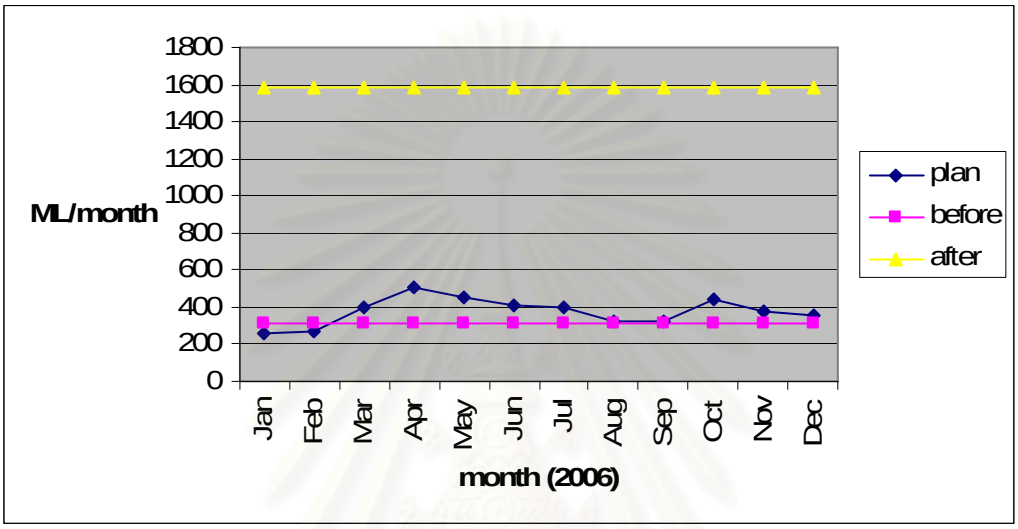


Figure 7.2: Ideal production volumes (Before & after implementation)

From figure 7.2, it can see that in the past, the company cannot support all of the demands, because some of them are over ideal production volumes. However, after implement the set up project, it can increase ideal production volume in a high number about 5 times. From that reason, the company can support customers' demands without trouble. Moreover, since the company can support more demands, it also can reduce manufacturing costs from 148.75 Baht per liter to 123 Baht per liter or approximately 17.31%.

Conversely, since this company is a food manufacturer, it should concern about food poisoning. For that reason, it should be controlled by HACCP system, which is one of the most important approaches. It eliminates the risks of food consumption and food poisoning, identifies possible areas of risk and minimizes or controls them.

As a result, to ensure that these improved processes do not risk for the customers should check them by the technical evaluation that is doing microbial test in every changing stage. All of these results should be in the HACCP standard.

For the ice-cream business, the microbial testing will test only three microbial, which can stay in the cool condition, that are SPC to be not more that 70 CFU/ml, Colifoam to be 10 CFU/ml or below and E. coli to be not more than 10 CFU/ 25 cm^2. From the testing data, every improved process passes the HACCP standard, so it can ensure that all of these processes do not poison to the end- products. Therefore, they can be applied in the actual area.

7.2 Recommendations for Further Study

The recommendations for the further study are presented in the following:

1. Using automatic cleaning equipment in cleaning filler and hopper or small equipment, because it can minimize the changeover time. Moreover, since it lacks of manual procedures, it can ensure that there is no microbial left behind in those equipment.
2. Because of each mould's weight, should use some material handling to help when moving mould pallet from storage to machine.
3. For cleaning tank more effectively, should cleaning by CIP process. This process is the most famous for cleaning tank, piping and even workplaces especially in food and beverage industries. It avoids of manual procedures especially in hygiene place, and there are several cycles by recirculating detergent and rinse solution. Thus, can ensure that there is no microbial left behind after cleaning process. The microbial test in this cleaning process is shown in table 7.3.

Table 7.3: Microbial test when implement CIP system

Part	**SPC (CFU/ml)**	**Coliform (CFU/ml)**	**E.coli (CFU/25cm^2)**
1. Tank Choc	<10	<10	<10
2. Tank Sauce	<10	<10	<10
3. Fruit feeder	<10	<10	<10
4. Mobile Tank	<10	<10	<10
5. Suction Unit	<10	<10	<10

Furthermore, it also can reduce downtime, because product changeover is minimized. It takes only about 45 minutes for cleaning tank and pipes. Besides, it also helps operator to do his job

more safety. Since CIP system is an automatic cleaning process without assembly and disassembly activities. Hence, he does not allow entering tanks or vessels like in existence, shown in figure 7.3. This activity is very dangerous behaviour.

Figure 7.3: Existing tank cleaning behaviour

Consequently, although CIP system has to spend an amount of money, the company can reduce manufacturing costs that are not only labour cost and energy cost but also safety cost.

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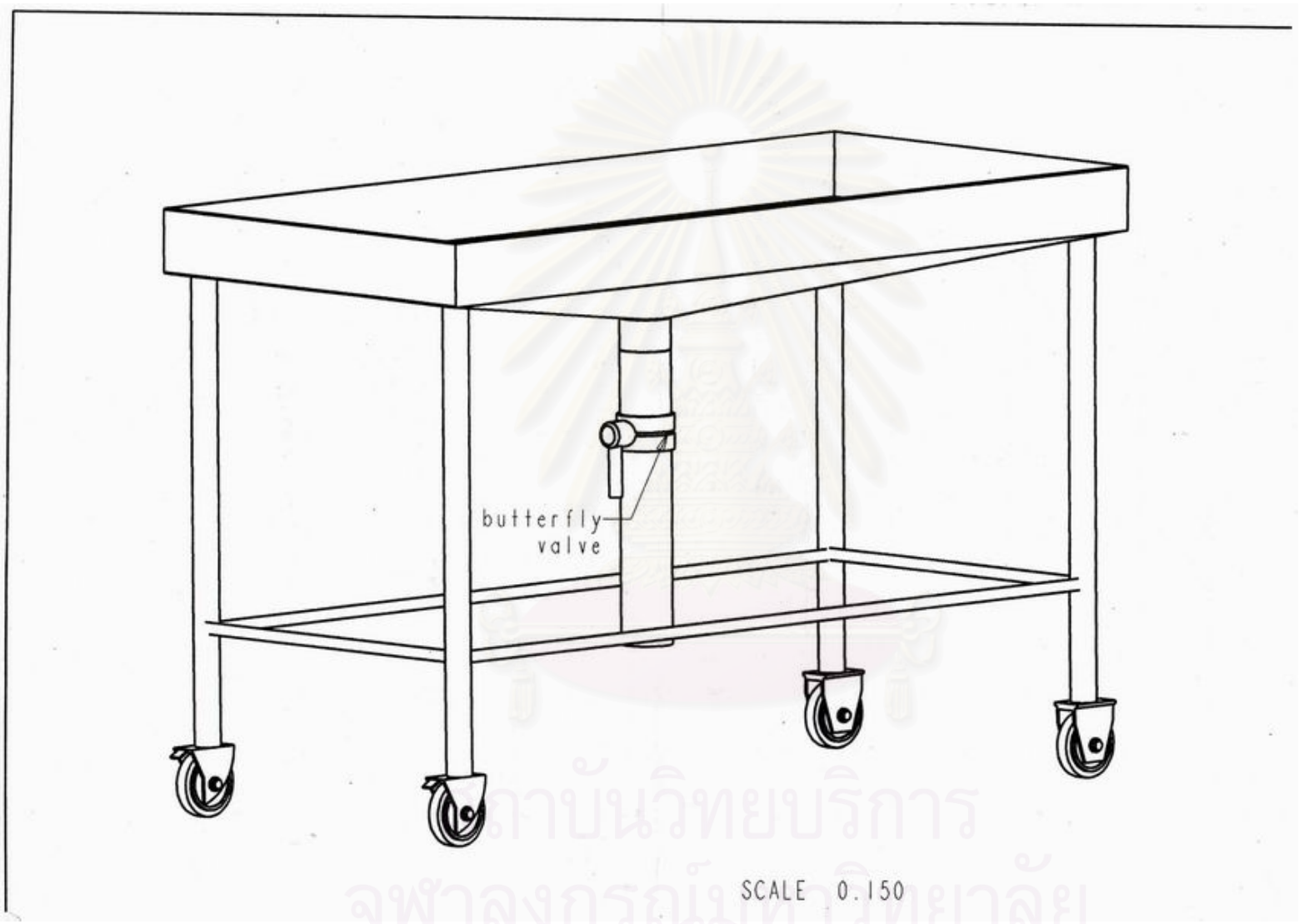
APPENDICES

APPENDIX A
DRAWING SKETCH



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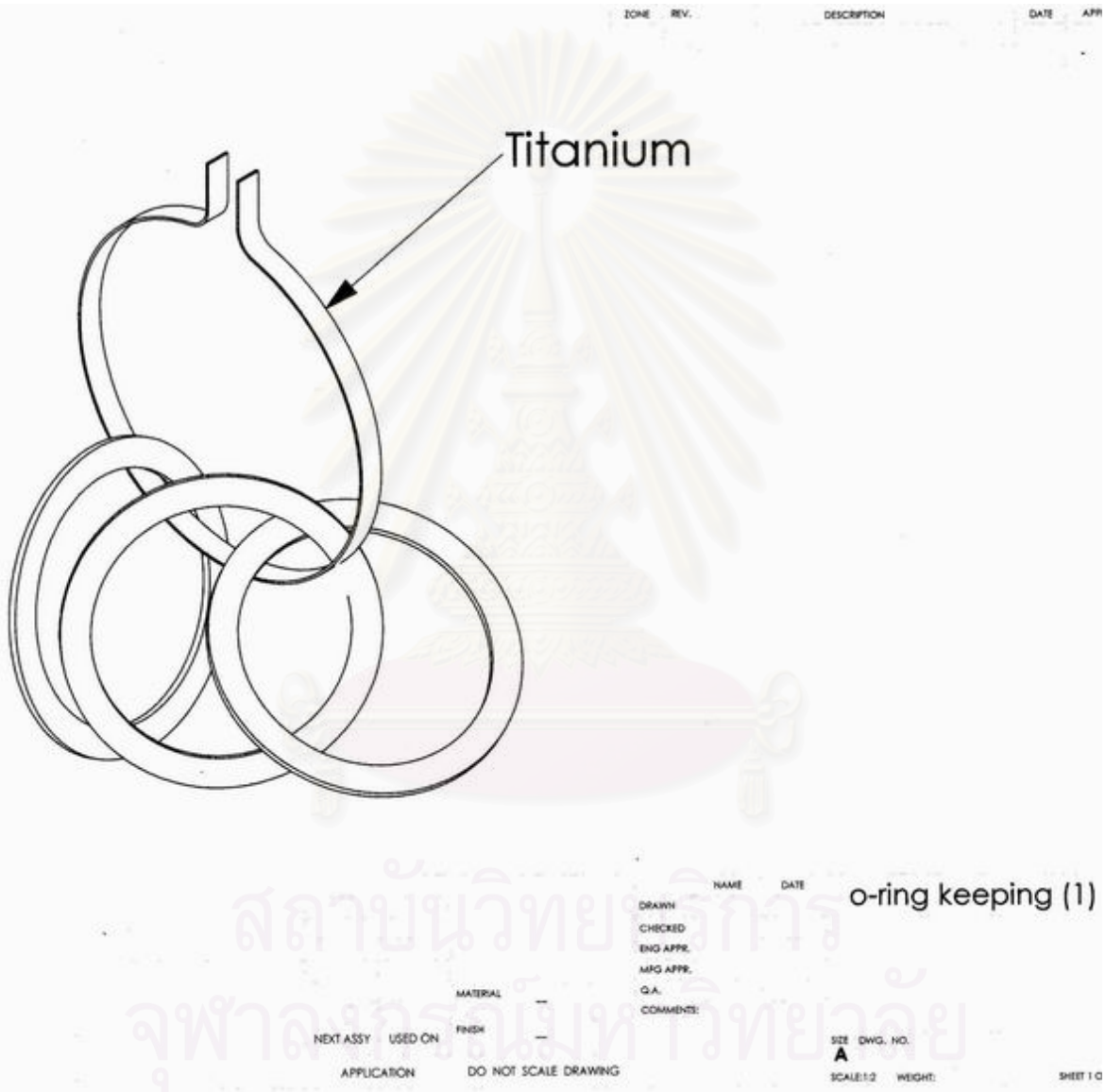
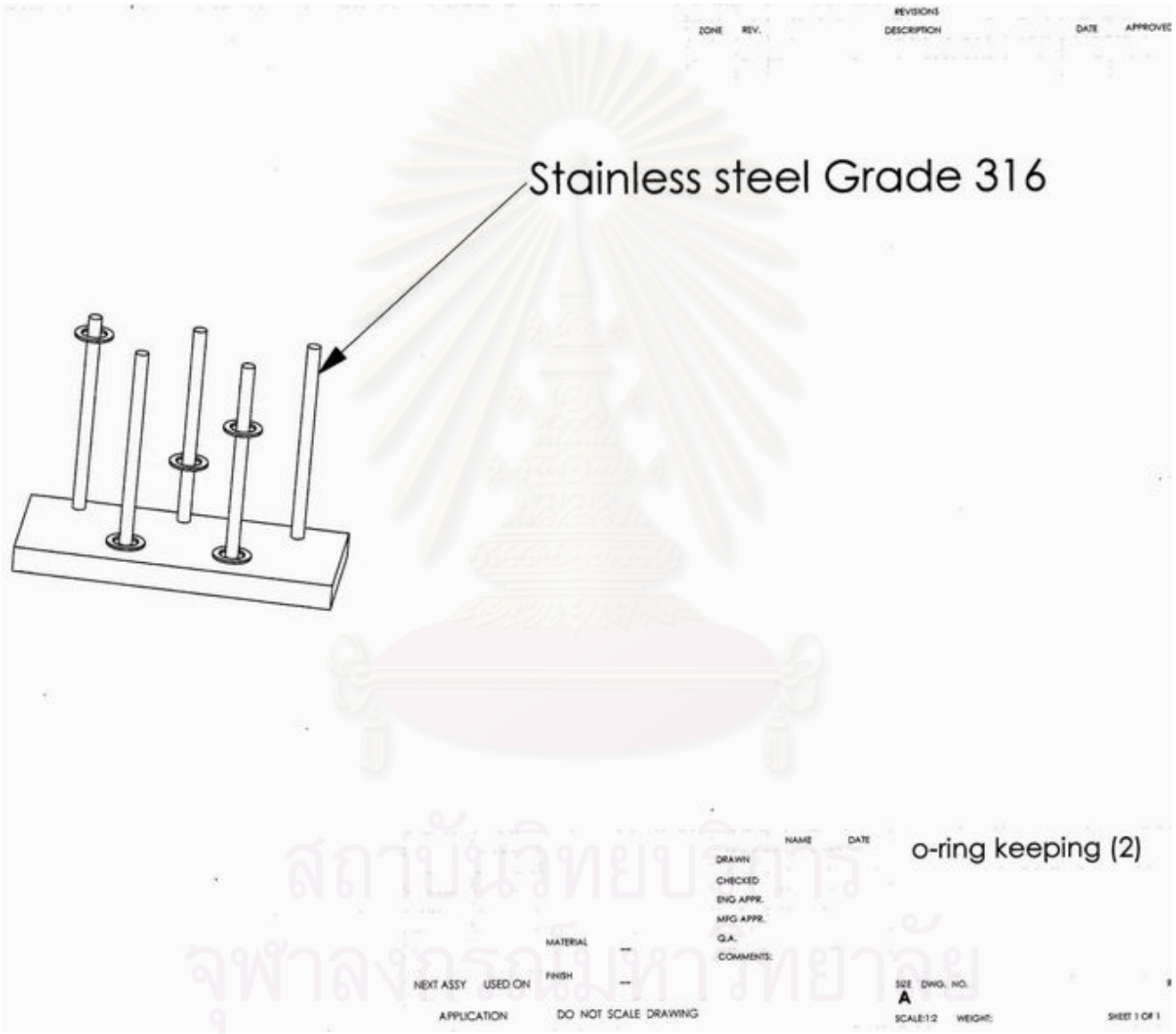
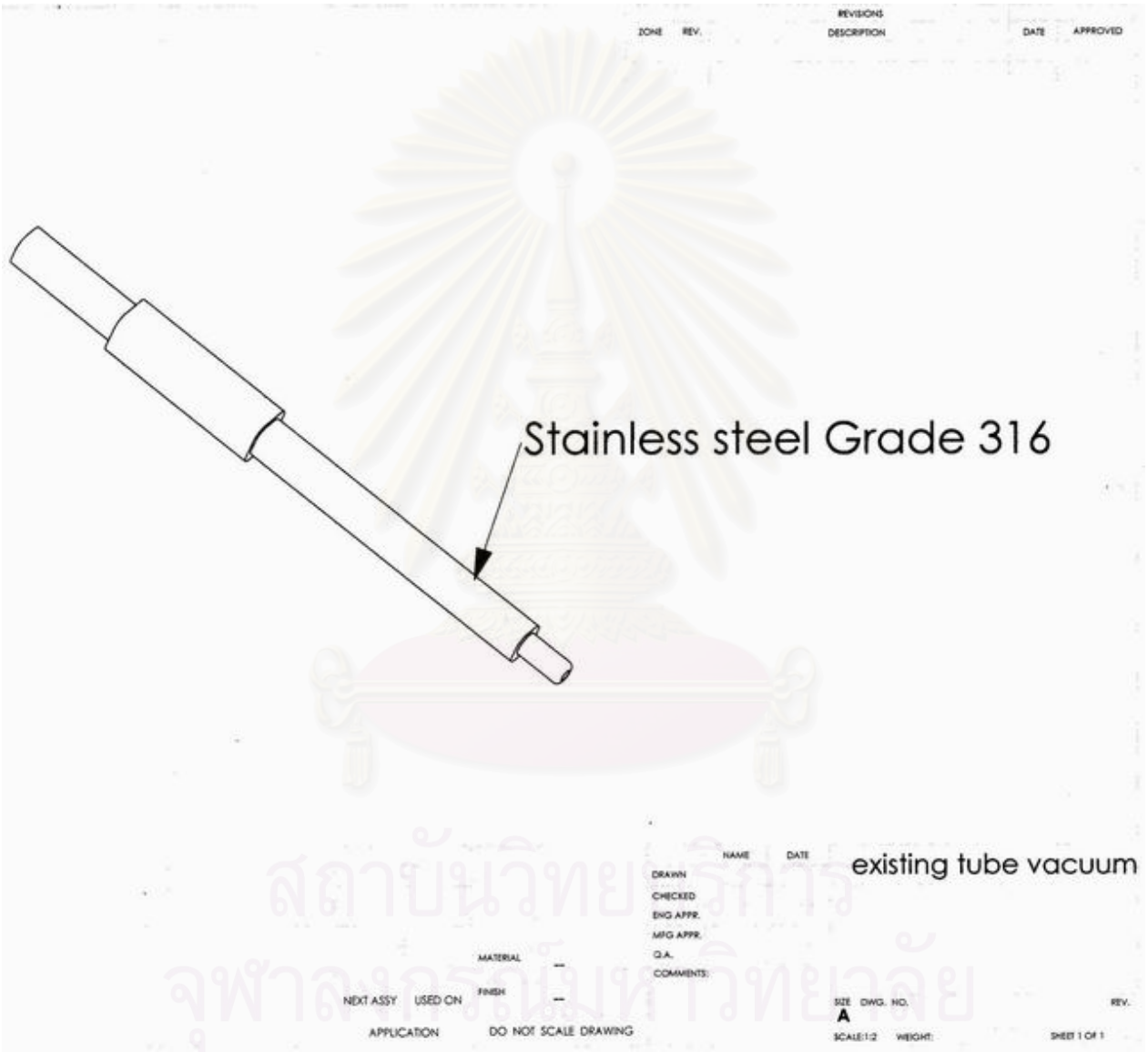

ZONE REV.
DESCRIPTION
DATE
Titanium
NAME
DATE
o-ring keeping (1)
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
MATERIAL —
FINISH —
NEXT ASSY USED ON
APPLICATION
DO NOT SCALE DRAWING
SIZE
A
DWG. NO.
SCALE:1/2
WEIGHT:
SHEET 1 O




REVISIONS
ZONE REV.
DESCRIPTION
DATE APPROVED
Stainless steel Grade 316
NAME DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
existing tube vacuum
MATERIAL --
FINISH --
NEXT ASSY USED ON
APPLICATION
DO NOT SCALE DRAWING
SIZE DWG. NO. REV.
A
SCALE:1:2 WEIGHT:
SHEET 1 OF 1

ZONE REV. DESCRIPTION DATE APPROVED

NAME DATE

DRAWN

CHECKED

ENG APPR.

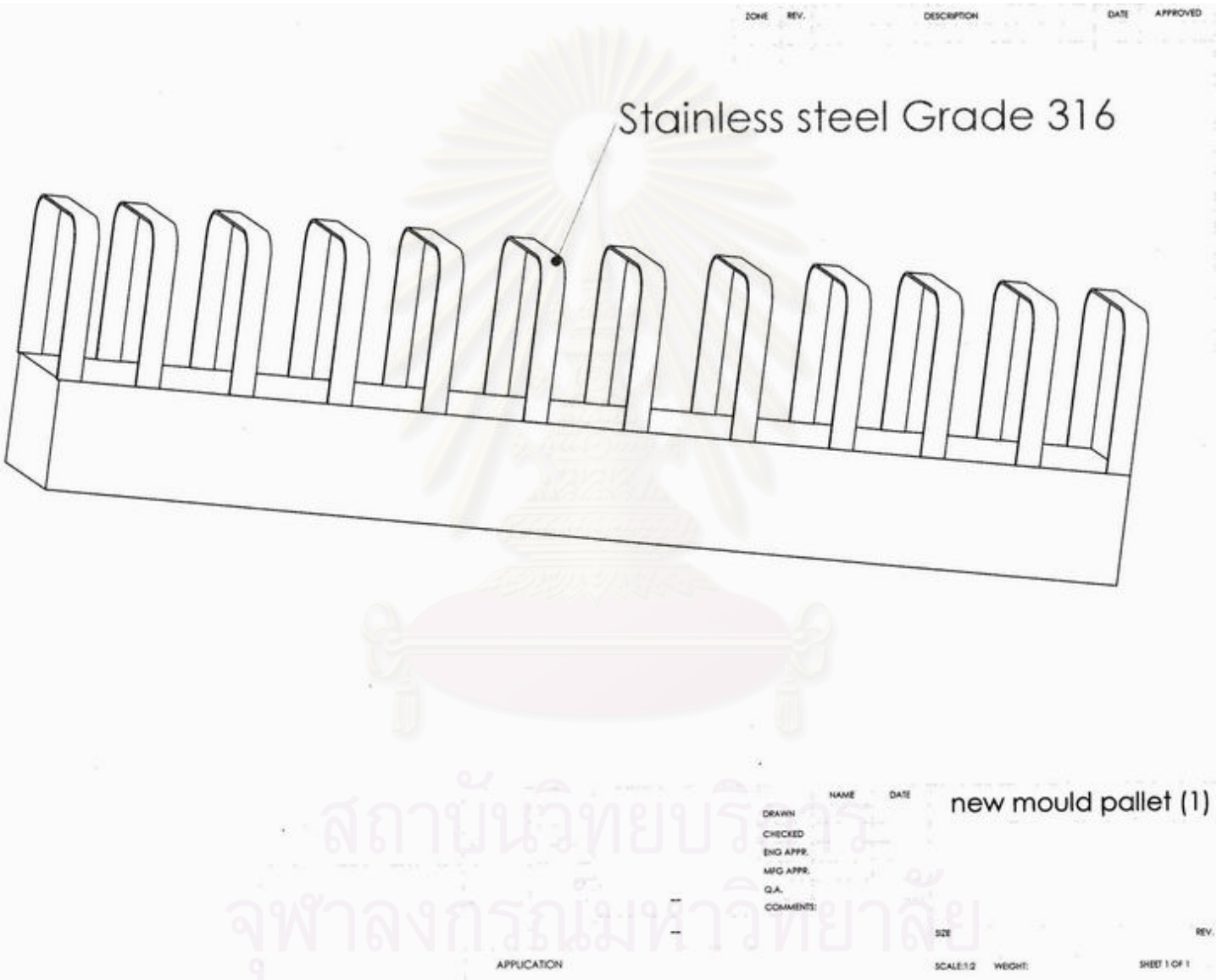
MFG APPR.

Q.A.

COMMENTS:

new mould pallet (2)

SIZE A DWG. NO. REV.



APENDIX B

MICROBIAL TEST DATA

70 ร.พิมพ์ IR Packing mix cleaning Jelly # 1 ฝาใส foam ge

บริษัท ยูนิลีเวอร์ไทยโฮลดิ้งส์ จำกัด แผ่นที่ 1 - 2 QA-F-AL 02 / 1

แบบฟอร์มขอรับบริการวิเคราะห์ผลิตภัณฑ์ในระหว่างผลิตและผลิตภัณฑ์สำเร็จรูป

จาก / From : I/R แผนก/Department : IR Packing ส่งถึง/To : Micro Lab, IC. ศิริพงศ์
วันที่/Date : 10 / 8/05 เบอร์ติดต่อ/Tel : 5590, 5413
Cost allocation : ☑ Sourcing Plant : IRC ☐ Dev. RIC Location :
☐ 3rd Party Plant : ☐ Dev. Local Location :
(ส่งแบบฟอร์มขอรับบริการ 2 ชุด สำหรับการวิเคราะห์ทางเคมี , ส่งแบบฟอร์มขอรับบริการ 2 ชุด สำหรับการวิเคราะห์ทางจุลชีววิทยา)

1. รายละเอียดของตัวอย่าง/Description of sample(State clearly what it is)

กลุ่มผลิตภัณฑ์ / Category : __Hair __Skin __Deo __Dental __Pers.W. __HHC __Laudry ☑IC __EF&D

ชื่อตัวอย่าง/Product	SIZE	CODE	วันเดือนปีที่ผลิต / Produced date	รายละเอียดเพิ่มเติม/Detail
Swab Peptone			10/8/05	12/10/05
			12/8/05	

ข้อควรระวังที่ควรทราบ / Cautions : ○ Toxic ○ Flammable ○ Irritant

2. วัตถุประสงค์ที่ต้องการทราบผลวิเคราะห์/Objective(State clearly the board objective)

☐ ศึกษาผลของผลิตภัณฑ์สูตรใหม่ New Product PROJECT :
(กรุณาระบุชื่อ หน้าที่ ปริมาณ ของ ส่วนประกอบที่เปลี่ยนแปลงและรายละเอียดเพิ่มเติมที่ควรทราบ)

Component	Function	Changed level	Detail

☐ ศึกษาผลการทำ Storage / Stability Test ที่ระยะเวลา _____ day / week / month
☐ ปัญหาคุณภาพที่ได้รับการร้องเรียนจากลูกค้า/Complaint (ได้แนบเอกสาร CCF register no. : _____ มาด้วย)
☑ อื่น ๆ / Other คือ : Using 50 61K

3. หัวข้อวิเคราะห์ (Item of analysis are as follow) ผลวิเคราะห์ / Result

		Spec.	SPC	Coliform	E.Coli			
3.1	1. Alfa หัวfill Jelly ก่อนล้าง	901	<10					
3.2	2. " " หลังล้าง	902	<10					
3.3	3 หัวfill Jelly ก่อนล้าง	903	<10					
3.4	4 " " หลังล้าง	904	<10					
3.5	5 กบ Hose ก่อนล้าง	905	<10	>10	>10			
3.6	6 " " หลังล้าง	906	<10					
3.7	7 ท่อง Holding Tank ก่อนล้าง	907	>1.5M					
3.8	8 " " หลังล้าง	908	<10					
3.9	9 Tank Jelly ก่อนล้าง	909	<10					
3.10	10 " " หลังล้าง	910	<10					

ชื่อผู้ขอรับบริการ/Requested by : ศรุตี
วันที่ / Date : 10 /10 /05
ชื่อผู้วิเคราะห์ : Jutty
วันที่ : 10/10/05
ชื่อผู้ตรวจสอบผล : ศิริพงศ์

QA-F-AL 02/1 :Rev. 5 : 11/09/2001

บริษัท ยูนิลีเวอร์ไทยโฮลดิ้งส์ จำกัด QA-F-AL 02 / 1

แบบฟอร์มขอรับบริการวิเคราะห์ผลิตภัณฑ์ในระหว่างผลิตและผลิตภัณฑ์สำเร็จรูป

จาก / From : สุภาวดี แผนก/Department : I/C Packing ส่งถึง/To : Microlab K.อิงอร์ I
วันที่/Date : 25/08/06 เบอร์ติดต่อ/Tel : 5561, 5590
Cost allocation : ☑ Sourcing Plant : I/C ☐ Dev. RIC Location :
☐ 3rd Party Plant : ☐ Dev. Local Location :
(ส่งแบบฟอร์มขอรับบริการ 2 ชุด สำหรับการวิเคราะห์ทางเคมี , ส่งแบบฟอร์มขอรับบริการ 2 ชุด สำหรับการวิเคราะห์ทางจุลชีววิทยา)

1. รายละเอียดของตัวอย่าง/Description of sample(State clearly what it is)

กลุ่มผลิตภัณฑ์ / Category : __Hair __Skin __Deo __Dental __Pers.W. __HHC __Laudry /IC __EF&D

ชื่อตัวอย่าง/Product	SIZE	CODE	วันเดือนปีที่ผลิต / Produced date	รายละเอียดเพิ่มเติม/Detail
Swab			อีหน้า 25/08/06 กะ	1
			26 AUG 2006	21.00 25-8-06
			Reported Date 28-8-06	

ข้อควรระวังที่ควรทราบ / Cautions :

2. วัตถุประสงค์ที่ต้องการทราบผลวิเคราะห์/Objective(State clearly the board objective)

☐ ศึกษาผลของผลิตภัณฑ์สูตรใหม่ New Product PROJECT :
(กรุณาระบุชื่อ หน้าที่ ปริมาณ ของ ส่วนประกอบที่เปลี่ยนแปลงและรายละเอียดเพิ่มเติมที่ควรทราบ)

Component	Function	Changed level	Detail

☐ ศึกษาผลการทำ Storage / Stability Test ที่ระยะเวลา day / week / month
☐ ปัญหาคุณภาพที่ได้รับการร้องเรียนจากลูกค้า/Complaint (ได้แนบเอกสาร CCF register no. : _____ มาด้วย)
☑ อื่น ๆ / Other คือ : Cleaning precese when using ao minutes in
original patern

3. หัวข้อวิเคราะห์ (Item of analysis are as follow)

			ผลวิเคราะห์ / Result					
			Spec.	SPC	Coliform	E-Coli		
3.1	Hopper	907		<10				
3.2	Arm	908		<10				
3.3	Filler (cfu/ml)	909		<10	<10	Absent		
3.4	Mould	910		<10				
3.5	Tip	911		<10				
3.6								
3.7								
3.8								
3.9								
3.10								

ชื่อผู้ขอรับบริการ/Requested by : ปรีชิน
วันที่ / Date : 25/08/06
ชื่อผู้วิเคราะห์ :
วันที่ : 26 AUG 2006
ชื่อผู้ตรวจสอบผล :

QA-F-AL 02/1 :Rev. 5 : 11/09/2001

บริษัท ยูนิลีเวอร์ไทยโฮลดิ้งส์ จำกัด QA-F-AL 02 / 1

แบบฟอร์มขอรับบริการวิเคราะห์ผลิตภัณฑ์ในระหว่างผลิตและผลิตภัณฑ์สำเร็จรูป

จาก / From : สุกัญญา แผนก/Department : I/C Packing ส่งถึง/To : Microlab ล.ลิลาวดี I,
วันที่/Date : 25/08/06 เบอร์ติดต่อ/Tel : 5561, 6590
Cost allocation : ☑ Sourcing Plant : I/C ☐ Dev. RIC Location :
☐ 3rd Party Plant : ☐ Dev. Local Location :
(ส่งแบบฟอร์มขอรับบริการ 2 ชุด สำหรับการวิเคราะห์ทางเคมี , ส่งแบบฟอร์มขอรับบริการ 2 ชุด สำหรับการวิเคราะห์ทางจุลชีววิทยา)

1. รายละเอียดของตัวอย่าง/Description of sample(State clearly what it is)

กลุ่มผลิตภัณฑ์ / Category : __Hair __Skin __Deo __Dental __Pers.W. __HHC __Laudry /IC __EF&D

ชื่อตัวอย่าง/Product	SIZE	CODE	วันเดือนปีที่ผลิต / Produced date	รายละเอียดเพิ่มเติม/Detail
Swab			วันที่ 25/08/06 กะ	1
			26 AUG 2006	2.00 25-8-06
			Reported Date 28-8-06	

ข้อควรระวังที่ควรทราบ / Cautions :

2. วัตถุประสงค์ที่ต้องการทราบผลวิเคราะห์/Objective(State clearly the board objective)

☐ ศึกษาผลของผลิตภัณฑ์สูตรใหม่ New Product PROJECT :
(กรุณาระบุชื่อ หน้าที่ ปริมาณ ของ ส่วนประกอบที่เปลี่ยนแปลงและรายละเอียดเพิ่มเติมที่ควรทราบ)

Component	Function	Changed level	Detail

☐ ศึกษาผลการทำ Storage / Stability Test ที่ระยะเวลา day / week / month
☐ ปัญหาคุณภาพที่ได้รับการร้องเรียนจากลูกค้า/Complaint (ได้แนบเอกสาร CCF register no. : _____ มาด้วย)
☑ อื่นๆ / Other คือ : Cleaning process when using 40 minutes in mixed chocolate patern

3. หัวข้อวิเคราะห์ (Item of analysis are as follow)

			ผลวิเคราะห์ / Result					
			Spec.	SPC	Coliform	E-Coli		
3.1	Hopper	907		<10	<10	Absent		
3.2	Arm	908		<10				
3.3	Filler (cfu/ml)	909		<10				
3.4	Mould	910		<10				
3.5	Jar	911		<10				
3.6	Tank	912		<10				
3.7								
3.8								
3.9								
3.10								

ชื่อผู้ขอรับบริการ/Requested by : ปรีชิน
วันที่ / Date : 25/08/06
ชื่อผู้วิเคราะห์ :
วันที่ : 26 AUG 2006
ชื่อผู้ตรวจสอบผล :

QA-F-AL 02/1 :Rev. 5 : 11/09/2001

บริษัท ยูนิลีเวอร์ไทยโฮลดิ้งส์ จำกัด QA-F-AL 02 / 1

แบบฟอร์มขอรับบริการวิเคราะห์ผลิตภัณฑ์ในระหว่างผลิตและผลิตภัณฑ์สำเร็จรูป

จาก / From : ศักดิ์ชัย แผนก/Department : I/C Packing ส่งถึง/To : Microlab K.จิตพงศ์ I,
วันที่/Date : 25/08/06 เบอร์ติดต่อ/Tel : 5561 6590
Cost allocation : ☑ Sourcing Plant : I/C ☐ Dev. RIC Location :
☐ 3rd Party Plant : ☐ Dev. Local Location :
(ส่งแบบฟอร์มขอรับบริการ 2 ชุด สำหรับการวิเคราะห์ทางเคมี , ส่งแบบฟอร์มขอรับบริการ 2 ชุด สำหรับการวิเคราะห์ทางจุลชีววิทยา)

1. รายละเอียดของตัวอย่าง/Description of sample(State clearly what it is)

กลุ่มผลิตภัณฑ์ / Category : __Hair __Skin __Deo __Dental __Pers.W. __HHC __Laudry /IC __EF&D

ชื่อตัวอย่าง/Product	SIZE	CODE	วันเดือนปีที่ผลิต / Produced date	รายละเอียดเพิ่มเติม/Detail
Swab			วันที่ 25/08/06 กะ	1
			26 AUG 2006	25-8-06
			Reported Date : 25-8-06	

ข้อควรระวังที่ควรทราบ / Cautions :

2. วัตถุประสงค์ที่ต้องการทราบผลวิเคราะห์/Objective(State clearly the board objective)

☐ ศึกษาผลของผลิตภัณฑ์สูตรใหม่ New Product PROJECT :
(กรุณาระบุชื่อ หน้าที่ ปริมาณ ของ ส่วนประกอบที่เปลี่ยนแปลงและรายละเอียดเพิ่มเติมที่ควรทราบ)

Component	Function	Changed level	Detail

☐ ศึกษาผลการทำ Storage / Stability Test ที่ระยะเวลา day / week / month
☐ ปัญหาคุณภาพที่ได้รับการร้องเรียนจากลูกค้า/Complaint (ได้แนบเอกสาร CCF register no. : _____ มาด้วย)
☑ อื่น ๆ / Other คือ : cleaning process when chang product from original patern to original patern

F

3. หัวข้อวิเคราะห์ (Item of analysis are as follow)

			ผลวิเคราะห์ / Result					
		Spec.	SPC	Coliform	E-Coli			
3.1	Hopper 907		<10	<10	Absent			
3.2	Arm 908		<10					
3.3	Filler (cfu/ml) 909		<10					
3.4	Mould 910		<10					
3.5	Tip 911		<10					
3.6								
3.7								
3.8								
3.9								
3.10								

ชื่อผู้ขอรับบริการ/Requested by : ปรัชญา ชื่อผู้วิเคราะห์ :
วันที่ / Date : 25/08/06 วันที่ : 26 AUG 2006
ชื่อผู้ตรวจสอบผล :

QA-F-AL 02/1 :Rev. 5 : 11/09/2001

บริษัท ยูนิลีเวอร์ไทยโฮลดิ้งส์ จำกัด

QA-F-AL 02 / 1

แบบฟอร์มขอรับบริการวิเคราะห์ผลิตภัณฑ์ในระหว่างผลิตและผลิตภัณฑ์สำเร็จรูป

จาก / From : ชลทัศ แผนก/Department : I/C Pack ส่งถึง/To : Microlab / ห้องทดลอง

วันที่/Date : 31/08/06 เบอร์ติดต่อ/Tel : 5590, 5561

Cost allocation : ☑ Sourcing Plant : IC ☐ Dev. RIC Location :

☐ 3rd Party Plant : ☐ Dev. Local Location :

(ส่งแบบฟอร์มขอรับบริการ 2 ชุด สำหรับการวิเคราะห์ทางเคมี , ส่งแบบฟอร์มขอรับบริการ 2 ชุด สำหรับการวิเคราะห์ทางจุลชีววิทยา)

1. รายละเอียดของตัวอย่าง/Description of sample(State clearly what it is)

กลุ่มผลิตภัณฑ์ / Category : __Hair __Skin __Deo __Dental __Pers.W. __HHC __Laudry ☑IC __EF&D

ชื่อตัวอย่าง/Product	SIZE	CODE	วันเดือนปีที่ผลิต / Produced date	รายละเอียดเพิ่มเติม/Detail
Swab Peptone				
			31/08/06	

Received Date 2-9-06 Time 13:30 2-9-06

By

Normal Urgent Standard Urgent

ข้อควรระวังที่ควรทราบ / Cautions :

2. วัตถุประสงค์ที่ต้องการทราบผลวิเคราะห์/Objective(State clearly the board objective)

☐ ศึกษาผลของผลิตภัณฑ์สูตรใหม่ New Product PROJECT :

(กรุณาระบุชื่อ หน้าที่ ปริมาณ ของ ส่วนประกอบที่เปลี่ยนแปลงและรายละเอียดเพิ่มเติมที่ควรทราบ)

Component	Function	Changed level	Detail

☐ ศึกษาผลการทำ Storage / Stability Test ที่ระยะเวลา day / week / month

☐ ปัญหาคุณภาพที่ได้รับการร้องเรียนจากลูกค้า/Complaint (ได้แนบเอกสาร CCF register no. : _____ มาด้วย)

☑ อื่น ๆ / Other คือ : Cleaning proces when chang product from ongrad pattern to mixed chocolate pattern

3. หัวข้อวิเคราะห์ (Item of analysis are as follow) (cfu/ml) (cfu/ml) ผลวิเคราะห์/Result (August 10,19)

		Spec.	SPC	Caliform	E. Coli			
3.1	Filler	906	<10	<10	Absent			
3.2	Mould	907	<10					
3.3	Tank	908	<10					
3.4	Arm	909	<10					
3.5	Hopper mix	910	<10					
3.6								
3.7								
3.8								
3.9								
3.10								

ชื่อผู้ขอรับบริการ/Requested by : ชลทัศ ชื่อผู้วิเคราะห์ :

วันที่ / Date : 31/08/06 วันที่ : 31 AUG 2006

ชื่อผู้ตรวจสอบผล :

QA-F-AL 02/1 :Rev. 5 : 11/09/2001

บริษัท ยูนิลีเวอร์ไทยโฮลดิ้งส์ จำกัด

QA-F-AL 02 / 1

แบบฟอร์มขอรับบริการวิเคราะห์ผลิตภัณฑ์ในระหว่างผลิตและผลิตภัณฑ์สำเร็จรูป

จาก / From : [illegible] แผนก/Department : I/C Packing ส่งถึง/To : Microlab /IC [illegible]

วันที่/Date : 30/08/06 เบอร์ติดต่อ/Tel : 5590 5561

Cost allocation : ☑ Sourcing Plant : I/C ☐ Dev. RIC Location :

☐ 3rd Party Plant : ☐ Dev. Local Location :

(ส่งแบบฟอร์มขอรับบริการ 2 ชุด สำหรับการวิเคราะห์ทางเคมี , ส่งแบบฟอร์มขอรับบริการ 2 ชุด สำหรับการวิเคราะห์ทางจุลชีววิทยา)

1. รายละเอียดของตัวอย่าง/Description of sample(State clearly what it is)

กลุ่มผลิตภัณฑ์ / Category : __Hair __Skin __Deo __Dental __Pers.W. __HHC __Laudry ☑ IC __EF&D

ชื่อตัวอย่าง/Product	SIZE	CODE	วันเดือนปีที่ผลิต / Produced date	รายละเอียดเพิ่มเติม/Detail
Swab Peptone				
30/08/06	กะ 3		31 AUG 2006	13.30
			Reported Date	By
			○ Roster	○ Standard ○ Larvae

ข้อควรระวังที่ควรทราบ / Cautions :

2. วัตถุประสงค์ที่ต้องการทราบผลวิเคราะห์/Objective(State clearly the board objective)

☐ ศึกษาผลของผลิตภัณฑ์สูตรใหม่ New Product PROJECT :

(กรุณาระบุชื่อ หน้าที่ ปริมาณ ของ ส่วนประกอบที่เปลี่ยนแปลงและรายละเอียดเพิ่มเติมที่ควรทราบ)

Component	Function	Changed level	Detail

☐ ศึกษาผลการทำ Storage / Stability Test ที่ระยะเวลา _____ day / week / month

☐ ปัญหาคุณภาพที่ได้รับการร้องเรียนจากลูกค้า/Complaint (ได้แนบเอกสาร CCF register no. : _____ มาด้วย)

☑ อื่น ๆ / Other คือ : cleaning process when change product from mixed chocolate patern to mixed chocolate patern

3. หัวข้อวิเคราะห์ (Item of analysis are as follow) (cfu/ml) (cfu/g) (Absent/25g)

		Spec.	SPC	Coli form	E. Coli			
3.1	Arm	901	<10	<10	Absent			
3.2	filler	902	<10					
3.3	Tank choe	903	50					
3.4	Stick	904	<10					
3.5	Mould	905	<10					
3.6								
3.7								
3.8								
3.9								
3.10								

ชื่อผู้ขอรับบริการ/Requested by : [illegible] ชื่อผู้วิเคราะห์ : [illegible]

วันที่ / Date : 30/08/06 วันที่ : 31 AUG 2006

ชื่อผู้ตรวจสอบผล : [illegible]

QA-F-AL 02/1 :Rev. 5 : 11/09/2001

บริษัท ยูนิลีเวอร์ไทยโฮลดิ้งส์ จำกัด

QA-F-AL 02 / 1

แบบฟอร์มขอรับบริการวิเคราะห์ผลิตภัณฑ์ในระหว่างผลิตและผลิตภัณฑ์สำเร็จรูป

จาก / From : JR   แผนก/Department : IR   ส่งถึง/To : MICRO LAB / K. [illegible]

วันที่/Date : 17/5/04   เบอร์ติดต่อ/Tel :

Cost allocation : ☑ Sourcing   Plant : ______   ☐ Dev. RIC   Location : ______

☐ 3rd Party   Plant : ______   ☐ Dev. Local   Location : ______

(ส่งแบบฟอร์มขอรับบริการ 2 ชุด สำหรับการวิเคราะห์ทางเคมี , ส่งแบบฟอร์มขอรับบริการ 2 ชุด สำหรับการวิเคราะห์ทางจุลชีววิทยา)

1. รายละเอียดของตัวอย่าง/Description of sample(State clearly what it is)

กลุ่มผลิตภัณฑ์ / Category : __Hair __Skin __Deo __Dental __Pers.W. __HHC __Laudry __IC __EF&D

ชื่อตัวอย่าง/Product	SIZE	CODE	วันเดือนปีที่ผลิต / Produced date	รายละเอียดเพิ่มเติม/Detail
ตัวอย่างทดลองเชื้อ			Product	

ข้อควรระวังที่ควรทราบ / Cautions :

2. วัตถุประสงค์ที่ต้องการทราบผลวิเคราะห์/Objective(State clearly the board objective)

☐ ศึกษาผลของผลิตภัณฑ์สูตรใหม่ New Product   PROJECT :

(กรุณาระบุชื่อ หน้าที่ ปริมาณ ของ ส่วนประกอบที่เปลี่ยนแปลงและรายละเอียดเพิ่มเติมที่ควรทราบ)

Component	Function	Changed level	Detail

☐ ศึกษาผลการทำ Storage / Stability Test ที่ระยะเวลา ______ day / week / month

☐ ปัญหาคุณภาพที่ได้รับการร้องเรียนจากลูกค้า/Complaint (ได้แนบเอกสาร CCF register no. : ______ มาด้วย)

☑ อื่นๆ / Other คือ : CIP system

3. หัวข้อวิเคราะห์ (Item of analysis are as follow)   ผลวิเคราะห์ / Result

	Item		Spec.	SPC	COLIFORM	E.COLI			
	Tank Oil	911		nil	Absent	Absent			
3.2	Tank Sauce	912		nil					
3.3	[illegible]	913		nil					
3.4	fruit feeder			nil					
3.5	mobile Tank			nil					
3.6	Suction Unit			nil					
3.7					Time 21.00			21-5-04	
3.8					Date		By		
3.9					Better		Standard	Lower	
3.10									

ชื่อผู้ขอรับบริการ/Requested by : [illegible]   ชื่อผู้วิเคราะห์ : [signature]

วันที่ / Date : 17/5/04   วันที่ : [illegible]

QA-F-AL02/1 :Rev. 5 : 11/09/2001   ชื่อผู้ตรวจสอบผล : [signature]

BIOGRAPHY

Chollaya Chotivetthamrong is the author of this thesis. She graduated with honour from Kasetsart University in industrial engineering. After her graduation, she attended to study her Master degree in Engineering Business Management at The Regional Centre for Manufacturing Systems Engineering, Faculty of Engineering, Chulalongkorn University and University of Warwick.