การทดแทนเครื่องจักรในกระบวนการบรรจุขวดน้ำมันปรุงอาหาร

นายเควิน กา บูน เตียว

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิศวกรรมศาสตรมหาบัณฑิต
สาขาการจัดการทางวิศวกรรม ภาควิชาศูนย์ระดับภูมิภาคทางวิศวกรรมระบบการผลิต
คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2550

MACHINE REPLACEMENT IN COOKING OIL BOTTLING PROCESS

Mr. Kevin Kah Boon Teoh

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Engineering Program in Engineering Management
The Regional Centre for Manufacturing Systems Engineering
Chulalongkorn University
Academic Year 2007

Thesis Title	MACHINE REPLACMENT IN COOKING OIL BOTTLING PROCESS
By	Mr. Kevin Kah Boon Teoh
Field of study	Engineering Management
Thesis Advisor	Assistant Professor Manop Reodecha, Ph.D.

Accepted by the Faculty of Engineering, Chulalongkorn University in Partial Fulfillment of the Requirements for the Master's Degree

.... Dean of the Faculty of Engineering

(Associate Professor Boonsom Lerdhirunwong, Dr.Ing.)

THESIS COMMITTEE

.... Chairman

(Professor Sirichan Thongprasert, Ph.D.)

.... Thesis Advisor

(Assistant Professor Manop Reodecha, Ph.D.)

.... Member

(Assistant Professor Paveena Chaovalitwingse, Ph.D.)

.... Member

(Associate Professor Somchai Puangphuaksook)

เควิน กา บูน เตียว: การทดแทนเครื่องจักรในกระบวนการบรรจุขวดน้ำมันปรุงอาหาร อ. ที่ปรึษา: ผศ. ดร. มานพ เรี่ยวเดชะ, 65 หน้า.

โครงการนี้ เป็นโครงการทดแทนเครื่องจักรในกระบวนการบรรจุขวดน้ำมันพืชในบริษัทแห่งหนึ่งโดยมีวัตถุประสงค์เพื่อการวางแผนและดำเนินการทดแทนเครื่องจักรทำขวดซึ่งมีกำลังการผลิตไม่เพียงพอ ทำให้เป็นคอขวดในกระบวนการบรรจุและเพื่อปรับปรุงประสิทธิภาพ เพื่อลดต้นทุนการผลิต

เมื่อได้ระบุความต้องการเบื้องต้นของโครงการแล้ว จึงได้ทำการศึกษาความเหมาะสมและความคุ้มค่าของทางเลือกต่างๆ ซึ่งระบุได้สี่ทางเลือก ความเหมาะสมของทางเลือก พิจารณาจากการเปรียบเทียบทางการเงิน ด้วยวิธีค่าเทียบเท่าจำนวนเงินเท่ากันรายปี (Equivalent Uniform Annual Cost) และเปรียบเทียบข้อพิจารณาที่ไม่เป็นตัวเงิน ด้วยวิธีให้คะแนนถ่วงน้ำหนัก (Weighted Scoring) ทางเลือกที่คัดได้คือ การติดตั้งเครื่องจักรใหม่พร้อมกับการปรับปรุงผังโรงงาน

การดำเนินการเพื่อติดตั้งเครื่องจักรใหม่ นำวิธีจัดการโครงการเข้ามาช่วย เมื่อดำเนินการเสร็จ ยังมีการประเมินผลเพื่อพิจารณาความสำเร็จของโครงการ ผลการประเมินพบว่าเครื่องจักรใหม่ที่ติดตั้งมีกำลังการผลิตตามความคาดหวัง ทำให้กำจัดคอขวดในกระบวนการบรรจุออก ซึ่งทำให้โรงงานผลิตได้เพียงพอต่ออุปสงค์ใน 5 ปีข้างหน้า นอกจากนั้นต้นทุนผลิตของขวดยังลดลง 20% เนื่องจากประสิทธิภาพที่ดีขึ้นจากการใช้เครื่องจักรใหม่ที่มีประสิทธิภาพสูง และการปรับปรุงการทำงานซึ่งลดการขนถ่ายวัสดุลงได้ถึง 55%

ศูนย์ระดับภูมิภาคทางวิศวกรรมระบบการผลิต
สาขา การจัดการวิศวกรรมศาสตร์..............
ปีการศึกษา.................2550.....................

ลงชื่อนักศึกษา..................................
ลงชื่ออาจารย์ที่ปรึกษา..........................

4971604721 : MAJOR ENGINEERING MANAGEMENT
KEY WORD: MACHINE REPLACMENT / FEASIBILTIY STUDY

KEVIN KAH BOON TEOH :MACHINE REPLACEMENT IN COOKING OIL BOTTLING PROCESS. THESIS ADVISOR : ASST. PROF. MANOP REODECHA, Ph.D., 65 pp.

This project is a machine replacement project in cooking oil bottling process in a company. The objective is to plan and implement the replacement of the bottle making machine. The bottle making machine needed replacing for two basic reasons that were its insufficient production capacity which caused the bottleneck in the bottling process and high cost per bottle because of inefficiency.

After the preliminary requirements of the project were identified, machine feasibility study was then done to sort out all the issues and to justify the selection of the option. Four options were considered. Justifications for option selection were based on financial comparison, using equivalent uniform annual cost, as well as intangible factors, using weighted scoring method. The selected option was to install a new machinery with some plant layout improvement.

The implementation was carried out with project management approach. Post-implementation audit was carried out to determine the success of the project. After implementing the project, the new machinery achieved the expected capacity to remove the bottleneck in the bottling process to make it meet the demand for the next five years. The production cost was lowered by 20%. The cost reduction was a result of the better efficiency of the new machine and the improved operation which reduced the handling of the bottles by 55%.

Regional Centre for Manufacturing Systems Engineering Student's signature...........................
Field of study...Engineering Management............ Advisor's signature...........................
Academic year ...2007...................

Acknowledgements

My gratitude firstly goes to my advisor, Assistant Professor Dr. Manop Reodecha, for his invaluable academic guidance and professional advice on this research. His broad devotion and dedication made this study possible.

Sincere appreciation is given to Morakot Industries PLC., for providing me with opportunities and resources to complete this study. Also I would like to thank the committee members, Professor Dr. Sirichan Thongprasert, Assistant Professor Dr. Paveena Chaovalitwingse for their constructive suggestions and comments on this study.

Finally, my deepest gratitude to my parents for their financial support and encouragement for this program which enabled me to complete my studies.

Contents

Page

Page

List of Tables

Page

List of Figures

Page

Chapter I
Introduction

This report describes the planning and implementation of machine replacement in a cooking oil bottling process. This is based on an existing cooking oil bottling company located in Thailand. Using the data obtained from the company under study and various existing literature with appropriate analysis, a system is proposed for the machine replacement process. This system can then be used for future reference for other machine replacement process and also for practical uses in other companies.

1.1 Background of the Research

The cooking oil bottling company under study has been in business for almost 20 years. The company does the fabrication of bottles and refining of the cooking oil. This results in having old machinery and processes. Over the years, the demand has reached the maximum output of the existing machinery of 180,000 cases per month. This is a significant increase from an initial capacity of 150,000 cases per month. The demand is expected to grow even more in the coming years. Also there is a bottleneck occurring within the existing bottling process which leads to inefficiency of production. The maximum refining capacity is at 100,000 MT where as the bottling capacity can only reach up to 30,000 MT. This is the one of the several main reasons to expand the bottling process. To improve the process there are several options available. One of these options is to purchase new machinery to improve the process. Most of the manufacturing problems that plagues the company under study can then be solved. However, other options include keeping the existing machinery and upgrading the existing machinery. Therefore it is important to provide justification of all the options available and select the best option to be implemented. The cooking oil bottling company under study has several problems with its current production line as outlined below.

First is the bottleneck occurring in the existing bottling process. This is because the refinery has larger refining capacity than the bottling process.

Second is the double handling of bottles within the production line. The production line is divided into two parts at two different locations. Due to space constraints at the factory, the blow moulding bottle machine is located in a rented warehouse nearby. The empty bottles that are produced in the rented warehouse are then transported in boxes to the factory where the filling line is located. The empty bottles are then unpacked manually and fed into the automated filling line. The finished goods are then repacked and sent back to the rented warehouse to be stored. Also at the same time back tracking is occurring as well.

The third problem is the low production capacity of the finished goods. The demand for the product has risen over the years where as the production capacity still remained the same. This has resulted in loss sales of the product. Figure 1.1 shows the total number of sales each year since 1995. Furthermore due to the slow production time, a warehouse for the finished goods is needed to meet delivery times and this incurs high costs.

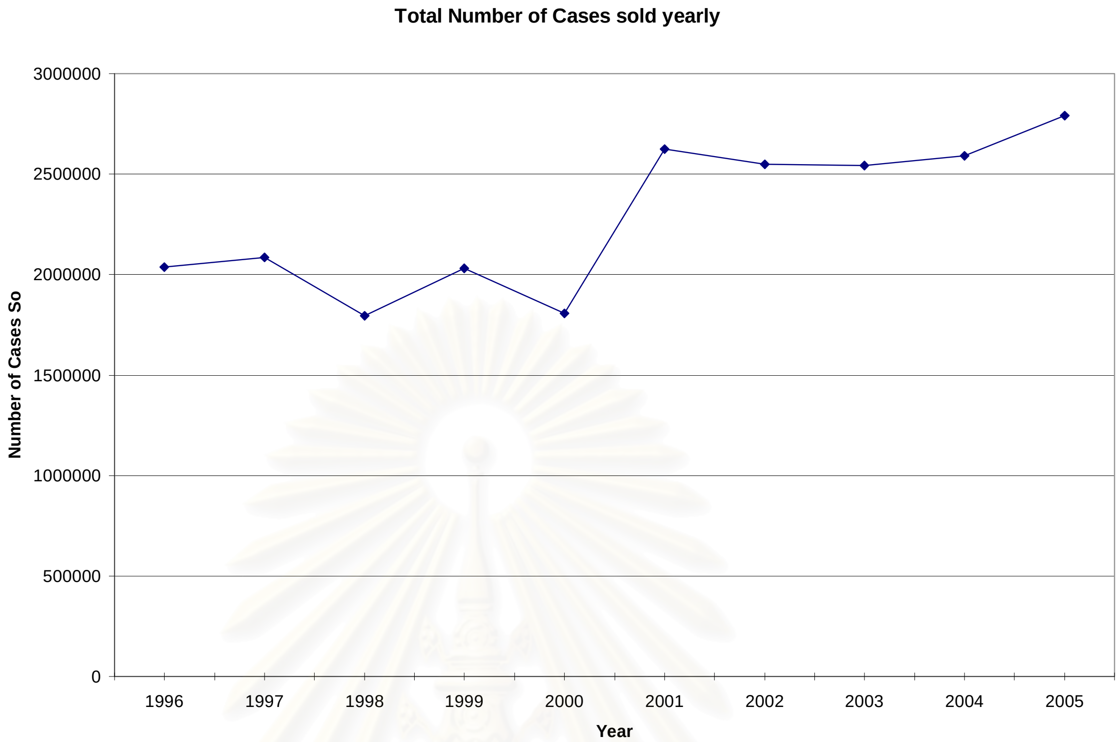

Figure 1.1 Total number of sales each year since 1995

The double handling system of the bottles and old machinery has resulted in a labour intensive line and high total cost per bottle ratio.

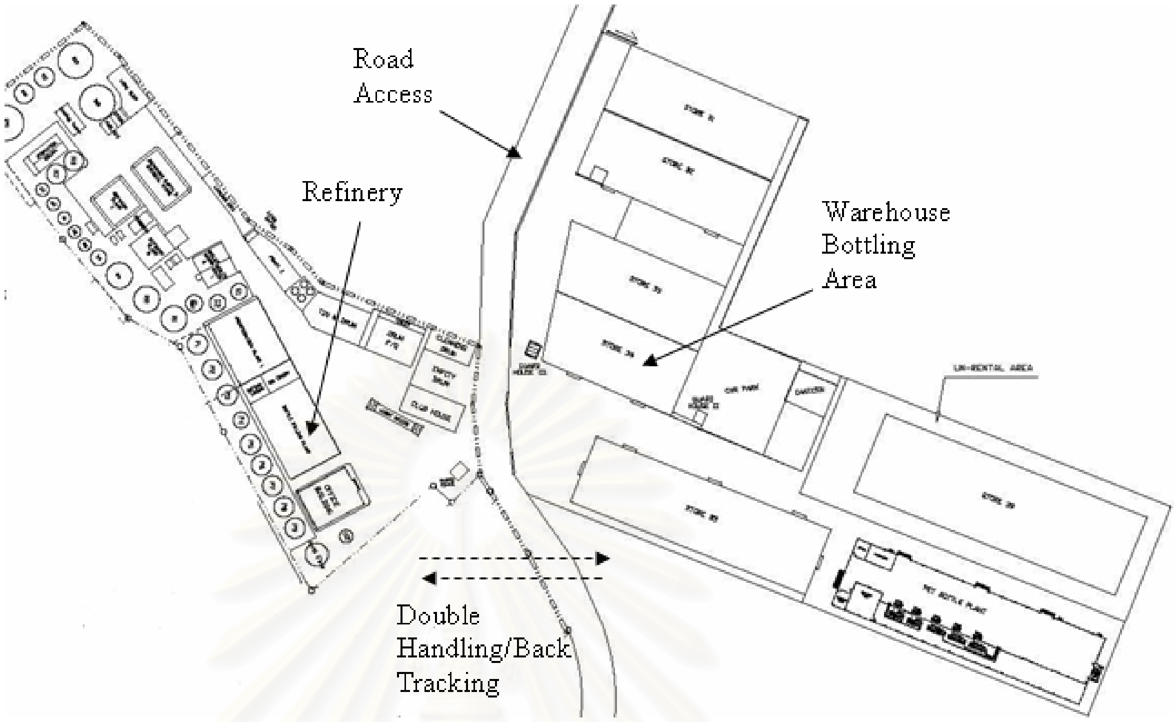

Figure 1.2 Double handling and back tracking of the bottles

1.2 Statement of Problems

The bottle making machine in the cooking oil bottling company needs replacing for the following reasons:

1) Low production capacity of goods unable to meet demand of the consumers.

2) Double handling and back tracking of the bottles within the production line as the blow molding machine is located elsewhere (Figure 1.2).

3) Bottleneck occurring in the existing bottling process.

4) High total cost per bottle ratio due to labour intensive line. Also the cost of rented warehouse(s) contributes to the high cost.

1.3 Objectives of Research

The objectives of this research is to plan and implement the replacement of the bottle making machine in a cooking oil bottling company in order to:

1) Increase its production capacity

2) Eliminate double handling between the production line and blow moulding machine.

3) Reduce bottleneck occurrence in the bottling process.

4) Reduction of cost per bottle to increase profit margin.

1.4 Scope of the Research

The research scope consists of the following:

1) Recommend a solution to improve the bottling process of the 1 litre production bottling line.

2) Provide justification of the recommended solution by feasibility study.

3) Implement the proposed system.

4) Conduct a post implementation audit of the proposed system

5) Recommend a second phase to the implementation process.

6) The feasibility study scope consists of marketing, technical and financial feasibility.

7) The market feasibility covers current market situation, current company position and forecasted demand of the products.

8) The technical feasibility study covers issues such as the labour requirements, capability, and the machine layout for existing and new machinery. This is based on the assumption that the labour rate is constant.

9) The financial feasibility covers the financial issues involved for existing and new machinery such as Equivalent Uniform Annual Cost. This is based on the assumptions that there are available funds for investment and the price of raw materials are constant which includes refined liquid palm oil, caps, labels, boxes, shrink wrap and adhesive.

10) The scope also covers the machine bottling process that is from the fabrication of the bottles up until to the packing of the bottles into the cases. However the scope does not cover the machine utilized to process and refine the liquid palm oil.

1.5 Expected Benefits

After the completion of the project it is expected that several benefits would be gained from the project. The expected benefits are outlined as shown below.

1) Provide improvements and solutions that solve the problems mentioned above.

2) Provide a fresh perspective for the organization under study on improving the production line.

3) Allow the company under study to be set as an example for the industry on improving the bottling process.

4) Beneficial to the academic community at large as there are few reports on specific cases like these that are available as open literature.

5) A methodology that will help with machine replacement process.

1.6 Methodology

The methodology that was done follows the general steps according with the project lifecycle as shown in figure 1.3 with the following steps below.

1) Problem formulation for machine feasibility study which provides information input for project planning. Problems that need to be solved within the company are identified.

2) From the first step, the project is defined with appropriate objective and scope. This includes detailed planning of the project to solve the identified problems. An analysis of machine feasibility study is then done with appropriate criteria.

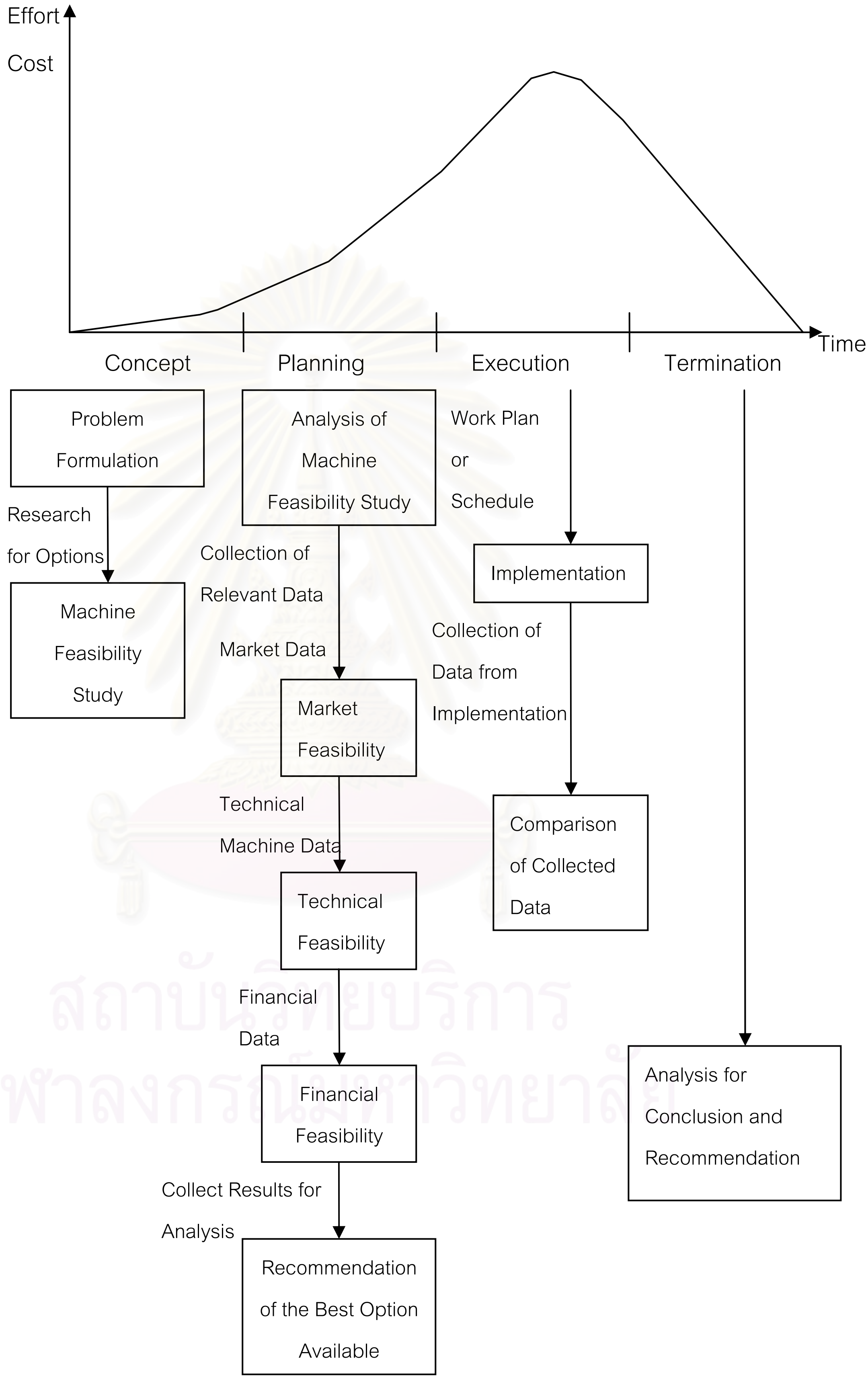

Figure 1.3 Project Lifecycle Methodology

3) For collection of relevant data for machine feasibility study, the data is divided into three different groups that are market, technical, and financial data. These data would then be applied for market, technical and financial feasibility study. The collected data is based on a combination of primary and secondary data that are available. The data utilized for the market feasibility would be the current sales data for the 1 litre palm oil bottle. This would also include previous sales year data as this can provide a forecast demand for future sales. For the technical feasibility, technical data such as production capacity per hour and labour required for the machine are used. For the financial feasibility the data utilized is the cost and investment involved.

4) The results of the feasibility analysis are then collected and analysed for the selection of the best option.

5) Using the work plan or schedule, the selected machinery is implemented. This is done during the execution phase of the project life cycle.

6) Data is collected from the implemented machine line for comparison and analysis.

7) Comparison and analysis of data is then done for before and after implementation.

8) Project is in the termination phase. Analysis for conclusion and recommendation is done.

Chapter II

Conceptual Framework for Machine Replacement and Related Theories

As the first chapter lays the groundwork for this report, this chapter will cover the introduction of framework and literature review in relation with the thesis. It will explain the theories that are related to the conceptual framework because it is important for the framework to be based on existing theories and to develop the theories further. The conceptual framework is designed for machine replacement so as to determine the best possible solution and provide justification. The main theory that is related to the framework is the feasibility study. Looking at the various theories of feasibility study the best methodology for machine replacement is selected.

2.1 Theoretical Concept

The main theoretical concept behind the planning and implementation of the machine replacement process deals with feasibility study. According to Attaprecha (1999), the aim of the feasibility study is to provide information that would help with the decision making process of beginning or continuing a project. It determines the best alternative under specific conditions for a project (Attaprecha, 1999). Also feasibility study must contain economic, financial, technical, commercial, and marketing elements that will contribute to the decision making process. However this is not entirely true as shown by Rukachantarakul (1998), where the feasibility study elements contains only financial and economic analysis.

As proposed by Baum et al. (1985), not all feasibility studies would cover the same exact areas but rather would be similar and involve different areas depending on the nature, complexity and magnitude of the project. However when doing feasibility study there are several questions that needs to be answered as shown below (Baum et al., 1985).

- Would the policy framework, be compatible and relevant with the project objectives?
- Does it offer the best technical options?
- Is the output of the project enough for demand?
- Is the project financially successful and economically justified?

Also according to Gottfried et al. (1984), a market feasibility study should have an analysis of the product as well as the estimated market demand for the product. To answer the questions above, the chosen feasibility study areas for this project are market, technical, financial analysis.

There are some other works that are related to machine replacement. One of them is by Cooper & Haltiwanger (1993), the work that was done is focused on the automobile industry on a large scale. Also the approach adopted was a broad mathematical approach. Another work that was done was by Vorster (2005), this work involves three aspects that are operational, mechanical, and financial. However this work does not have enough details about the machine replacement process itself.

2.2 Framework for Feasibility Study

After research into other feasibility study reports as mentioned above, the conceptual framework for feasibility study would generally consists of 3 areas that are, market, technical and financial feasibility.

2.2.1 Market Feasibility

The market feasibility aims to look at the market potential of sales with the new capacity achieved upon upgrading the machinery. The market feasibility will consist of current market status, market positioning of the company, market opportunity available, meeting the needs of the market, and expected improvements of the market. The market opportunity available will look at the demand trend and price fluctuation of the market. To meet the needs of the market, we will look at part of the marketing strategy for the product. For the expected improvements of market, it will look at the forecasted demand based on the analysis of the current market status, market position of the company, and the market opportunity that are available.

2.2.2 Technical Feasibility

The technical feasibility would look at the technical aspects of the machinery particularly on the technical needs as well as the capability of the machinery. For the technical feasibility, will consist of expected capacity, labour required, amount of electrical power required, physical dimensions of the machine, and plant layout. The physical dimensions of the machine will estimate the space or floor area that is required for plant layout based on the dimensions of the machine.

2.2.3 Financial Feasibility

The financial feasibility looks at the financial viability of the machinery based on several financial measures. The financial measures also aim to look at two different aspects of finance that are the profitability and funding for the project. The profitability measure includes cash flow analysis. These measures may be used together or as alternatives. The amount and timing of cash flows and the sources of funds are considerations in project funding. The following describes some financial measures, namely equivalent uniform annual cost, cash flow analysis, and source of funds.

Equivalent Uniform Annual Cost (EUAC)

Definition: The EUAC is the annual worth of a prime cost cash flow pattern for a project (Sullivan, 2006).

Condition of acceptance: Lowest EUAC value possible compared with other project options available.

Advantage: Takes into account time value of money.

Disadvantage: Requires complex calculation and accurate data.

The cost per year for comparing alternatives is found by the equation:

$$CostPerYear(i\%) = I(A/P, i\%, N) - S(A/F, i\%, N)$$

Where *I* = Capital Investment

S= Market value at the end of the study period

N= Study period in years

i= Minimum attractive rate of return

$$A/P = \frac{i(1+i)^N}{(1+i)^N - 1} \qquad A/F = \frac{i}{(1+i)^N - 1}$$

Where *A/P* is the annual present worth of the asset with a cash flow of uniform series beginning of each period of *N* where *I* is the interest rate. This formula is also known as the capital recovery factor (Sullivan, 2006). *A/F* is defined as the annual future worth that is a cash flow with uniform series for its future value. This is also known as the sinking fund factor.

Cash Flow Analysis

Definition: Measures the direct potential cost savings that can be gained upon upgrading of the machinery. It compares the cost associated before and after upgrading. This would show the direct savings involved of the new machinery.

Condition of Acceptance: With positive value of savings the project should be accepted and vice versa.

Advantage: Ease of calculation and comparison of savings gained.

Disadvantage: Simple measurement may not show true savings gained.

Source of Funds

Definition: The source of fund will identify the source of funding for the project and the contributing factors that would allow the company to gain to funds for investment.

Advantage: Identifies the funding availability for the project.

Disadvantage: Does not have tangible value for analysis.

Chapter III
Project Feasibility

In chapter 2 the related literature to the conceptual framework was identified. In chapter 3 project feasibility will show how to apply the related literature to the project of machine replacement. Because this is where the theory will be practiced and logical conclusions will be drawn based on the machine replacement criteria and the options that are available. Another reason for this chapter is to be able to select the most suitable machinery using appropriate analysis based on theory. This will include detailed data that are obtained from the company under study. The first step is to conduct a market feasibility study to determine the capacity that is required to fulfill the demand. Next the machine replacement requirements are identified so as to able to improve the current system. Thirdly, the alternatives available are identified to be able to make a comparison between them by looking at the advantages and disadvantages of each of them. Then the initial screening of the alternatives is done before the detailed feasibility study analysis. Lastly, the feasibility study analysis is done so as to be able to select the appropriate machinery for the company under study based on the feasibility criteria. This chapter will cover basic problems, basic requirements, procedure for analysis and design, general background, operational requirements, preliminary alternatives, initial screening, feasibility analysis and selection.

3.1 Basic Problems

There are two basic problems that need to be identified first. The bottle making machine in the cooking oil bottling company needs replacing for the following reasons:

1) Insufficient production capacity which was caused by the bottleneck in the existing bottling process.

2) High cost per bottle because of inefficiency.

3.2 Basic Requirements

As the company manufactures various bottle sizes of cooking oil using various machines, the basic requirements need to be identified. The first basic requirement is that the market for the 1 litre bottle is growing faster than other bottle sizes. Also the 1 litre contributes the most profits for the company under study. This is shown further in the market feasibility study. Hence the first basic requirement is to improve the process of the 1 litre bottle making machine. The second basic requirement is increasing the capability of manufacturing the 1 litre bottle that is from 180,000 cases per month to 290,000 cases per month within four years. This is further justified in the technical feasibility study.

3.3 Procedure for Analysis and Design

The procedure for analysis and design consist of several steps. The first step is to identify the operational requirements for machine replacement. The second step involves identifying alternatives available for machine replacement. Knowing the alternatives that are available, justification can then be done by market feasibility study. The technical and financial feasibility study would then identify the options that would be the most suitable for the company needs. The options that are unsuitable for the company would be eliminated. By process of elimination, the replacement selection is then identified.

3.4 General Background

The flow process of bottle making will be described in this section. The current process of bottle making is as shown in the figure below. The inefficiency with the current process flow is after the fabrication of the bottle. The empty bottles have to be packed and transported to a nearby location for filling of the bottles. Then the bottles would be capped and repacked to be transported back to the labeling line for labeling of the bottles. The bottles would then be properly packed into cases of 12 and palletized accordingly.

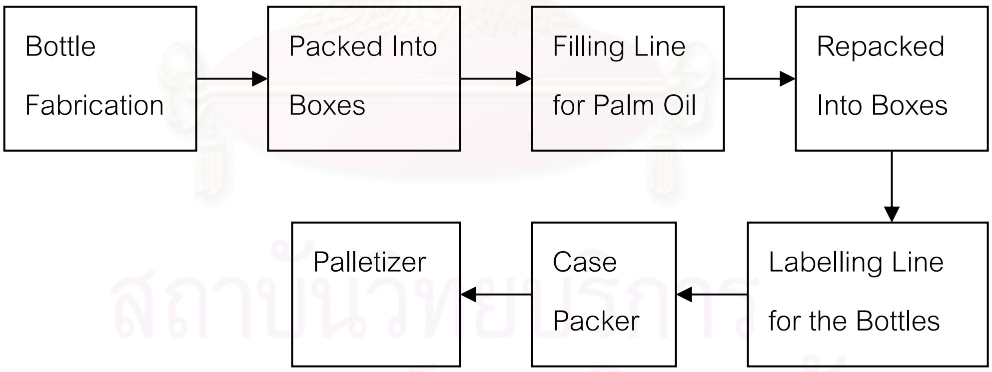

Figure 3.1 Current Process Flow of Bottle Making

After machine replacement the flow process of bottle making will improve by eliminating the inefficiency of double handling. This will result in having a continuous process flow from bottle fabrication until palletizing of the cases.

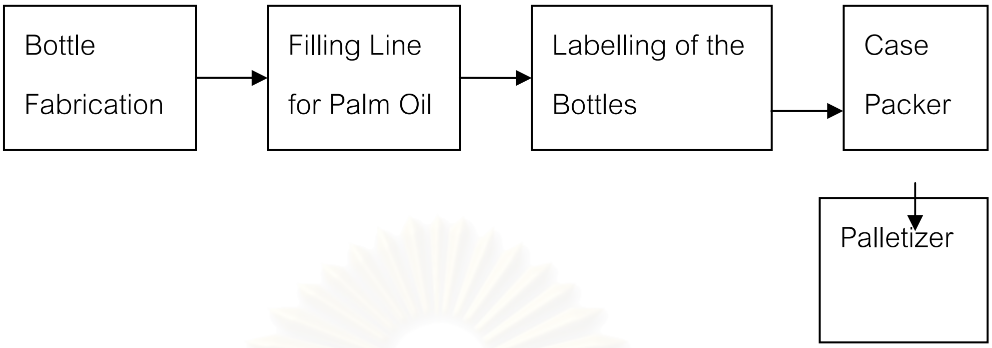

Figure 3.2 Improved Process Flow of Bottle Making

3.5 Operational Requirements for Machine Replacement

There are two operational requirements that the machine replacement needs to be considered so as to be able to improve the current system. They are process improvement and obsolescence as shown below.

3.5.1 Process Improvement

The current process needs to be improved because of several factors. Firstly there is a bottleneck occurring when manufacturing the product. The bottleneck has occurred where the production of the PET (Polyethylene Terephthalate) bottles is insufficient to cope with the rest of the line. Secondly the current process consumes a significant amount of wastage and hence it is slowly becoming cost inefficient.

3.5.2 Obsolescence

The current machinery that is used also contributes to the machine replacement requirements. This is because the current machinery is more than 10 years old and is in need of replacement. Also due to the age of the machinery, it may not be worthwhile anymore to continue using the machine as the maintenance cost would gradually rise over the next few years. Hence new machinery is required to replace the current machinery to improve the system and the process.

3.6 Preliminary Alternatives

At this stage we would look at the alternatives available to meet the machine replacement requirements mentioned above by identifying the options of machinery available to implement into the bottling process.

1) Using Existing Machinery and Outsourcing (Option 1)

The first option is to keep the existing machinery and outsource the bottle production for the extra capacity. This is assuming that the current capacity of the existing machinery can be sustained. A summary of the advantages and disadvantages are as listed below.

Advantages

- Familiarity and flexibility with machinery.
- Maintenance knowledge already available to maintain the machine.
- No capital outlay.

Disadvantages

- The maintenance cost is currently high and may go higher with time.
- Still low production capacity.
- High production cost due to problems as stated in chapter 1.
- Logistically cost inefficient when outsourcing.

2) SIPA Machinery (Option 2)

The second option would be the machinery from the SIPA supplier. SIPA is an Italian company that specializes in single stage machines. The recommendation from the SIPA supplier is to purchase a single stage machine (FX 20/64) equipped with a blower (SP 2/2) that will produce 1 Litre PET bottles and also be able to produce ¼ Litre PET bottles as well. Below is the summary of the advantages and disadvantages of purchasing the machine.

Advantages

- Supplier SIPA company is a reputable and well known company throughout the world
- Have an established office in Bangkok, Thailand which would help with maintenance and communication.
- Calculated cost per bottle would be very low.
- Flexible in producing the desired capacity as well as the size of the bottles.
- One machine is only recommended which in turn helps saves storage space.
- Maintenance coverage of 10 years.

Disadvantages

- The investment required has to be a one time investment.

3) ASB Machinery (Option 3)

The third option is to upgrade the existing machinery. The supplier that offers this option is from a Japanese company called ASB which recommends using the existing machinery but instead equipped with new molds. Also to purchase ASB machinery in the year 2006 (PB 170/170 B 2/8) and 2009 (PB 170/170 32/8) that will increase the capacity gradually. This involves modifying the machinery to have the capabilities of a new machine. Below is summary of the advantages and disadvantages of purchasing the machine.

Advantages

- As the company under study is using the existing ASB machines, then this would give good familiarity with the new ASB machines as well.

Disadvantages

- Multiple machines to purchase and use may result in greater space utilization and also high cost of machinery storage.
- Existing ASB machinery has resulted in gradual high maintenance cost and inefficient use of resources.
- The company ASB is better known for their machines that can provide smaller capacities.
- Maintenance coverage of only 3 years.

4) Sidel and Husky Machinery (Option 4)

The fourth option is the machinery supplied by Sidel and Husky Company. The recommendation from Sidel and Husky is that it involves two separate machines that are one for production of performs (3L 300 PET P100/100E) by Husky and the other for blowing of performs into bottles (Combi Nissei) by Sidel. Below is the summary of advantages and disadvantages.

Advantages

- The Sidel and Husky combination two-stage machine is well known for being the best.
- High flexibility.
- Cost per bottle could be lower than that of the existing machinery.

Disadvantages

- Very high capacity of 840,000 cases/month and may be too much as the current required capacity is not that high.
- Storage space and extra handling is needed as performs cannot be blown into bottles straightaway.
- Dealing with 2 different suppliers as the machines are separately supplied.
- High cost due to higher capacity.

3.7 Initial Screening

Initial screening shows that the machine supplied by Sidel and Husky is very unsuitable for the needs of the company under study. The capacity offered by Option 4 shows that it has far too much capacity and hence may not run full capacity within the first 5 years. Also even if it is used for production of all the different bottle sizes, the investment cost is not worth it. The cost associated with it could be very much higher compared to the other options that are available. Existing machines that are manufacturing other bottle sizes is still currently able to cope with the demand. Hence from the initial screening Option 4 is not a viable option and will not be further justified.

Base on the initial look at the recommendations and the advantages and disadvantages, shows that the SIPA machinery advantages outweigh its disadvantages significantly. However, further investigation is required to validate and select the appropriate machinery. The areas of feasibility study that is covered are technical and financial feasibility. Within each area of feasibility study are further details on suitability of the various options of machinery and will show the appropriate justification as well.

3.8 Market Feasibility and Capacity Requirement

Market feasibility was conducted to determine the requirement of the planned capacity expansion. The market feasibility study consist of 5 areas that are the current market status, market positioning of the company, market opportunity available, meeting the needs of the market, and expected improvements of the market.

1) Current Market Status

Looking at the overall market for cooking oil in Thailand has shown a continuous growth over the past few years. According to Nielsen, 2007 the latest growth percentage is at 8.9% which is a jump from the previous year of 8.4%. This is measured in terms of volume. Also this growth is contributed by the growing importance of the Supermarket/Hypermarket (S/H) from 29% to 30% and Traditional Trade (TT) distribution channel from 37% to 38% as shown in the figure below. This conforms to the general increasing trend of sales of volume since December 2004. With the growth of the overall market for Thailand palm oil sales contribution have also steadily risen since December 2004.

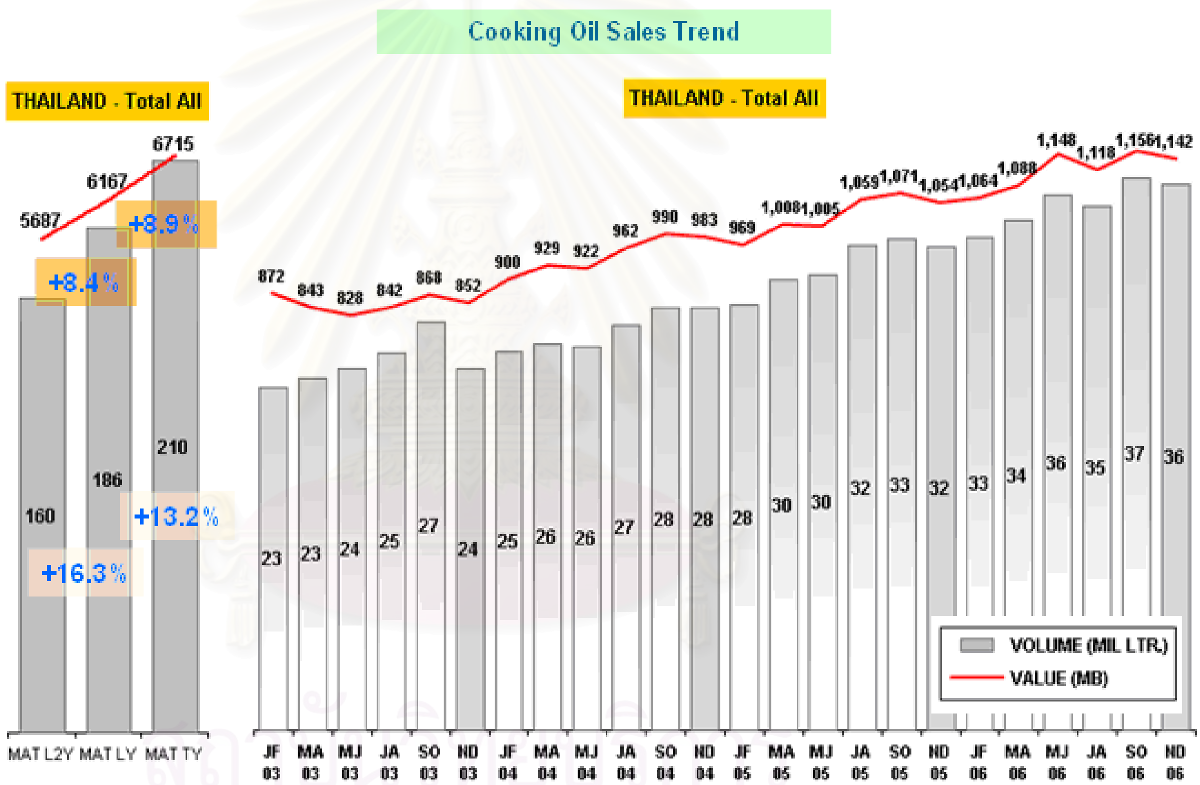

Figure 3.3 Overall Cooking Oil Sales Trend Source: Nielsen, 2007

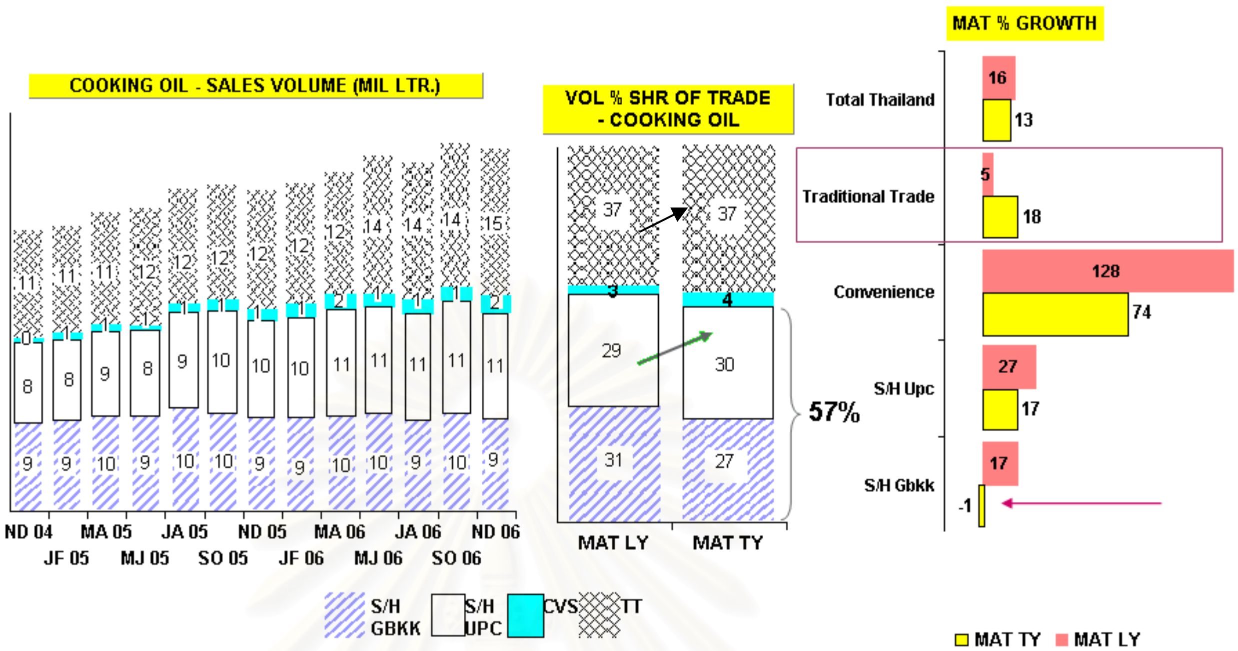

Figure 3.4 Volume Distribution Channel Source: Nielsen, 2007

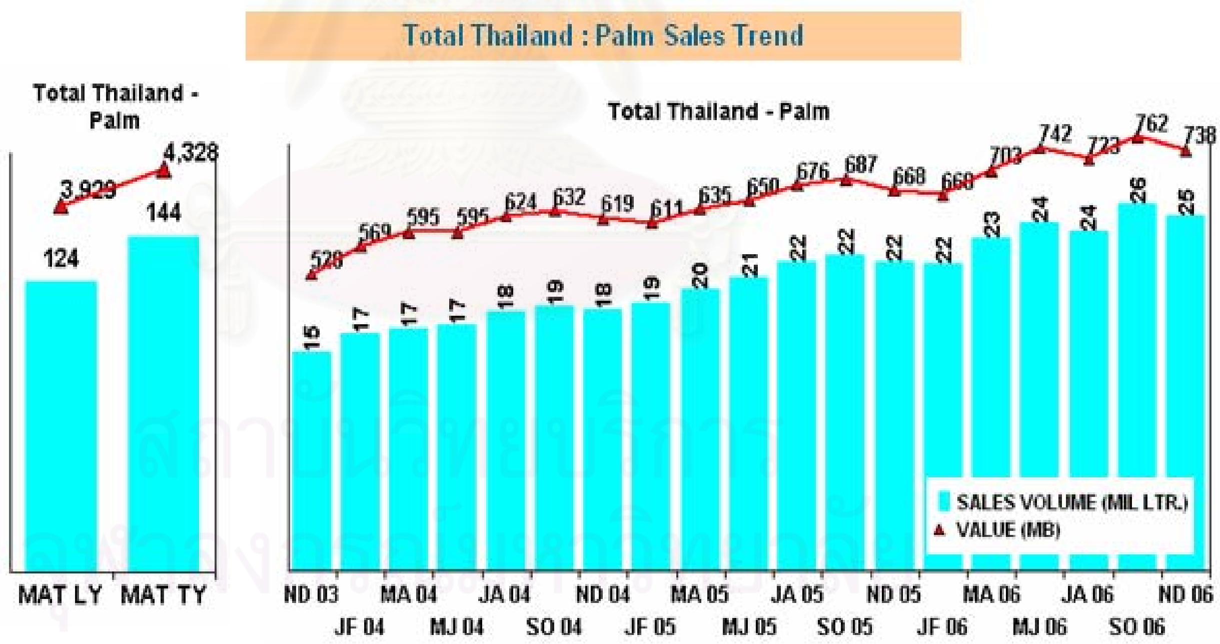

Figure 3.5 Palm Oil Sales Trend Source: Nielsen, 2007

2) Market Position of the Company

Figure 3.6 shows the market share of the palm segment for the company under study. The palm oil market share has a steady increase of market growth since 2001 up to 2003. However the market share has decreased by 8% since then due to increasing competition.

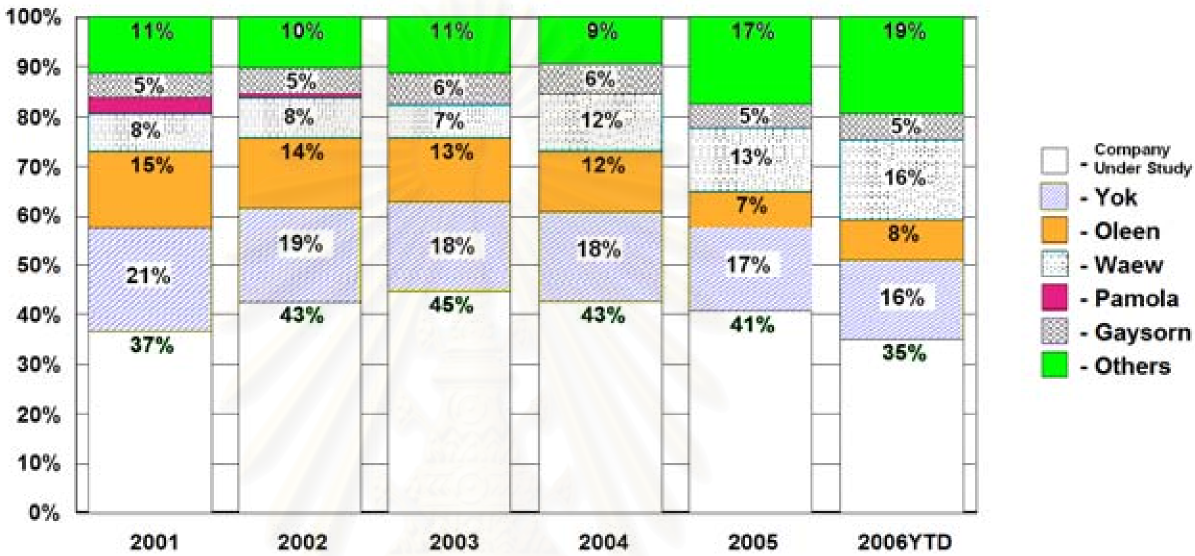

Figure 3.6 Market Share of Palm Oil Segment Source: Morakot, 2006

Looking in more detail, the palm oil 1L bottle contributes steadily in the Traditional Trade distribution channel as shown in Figure 3.7 relative to the other competitors in the market.

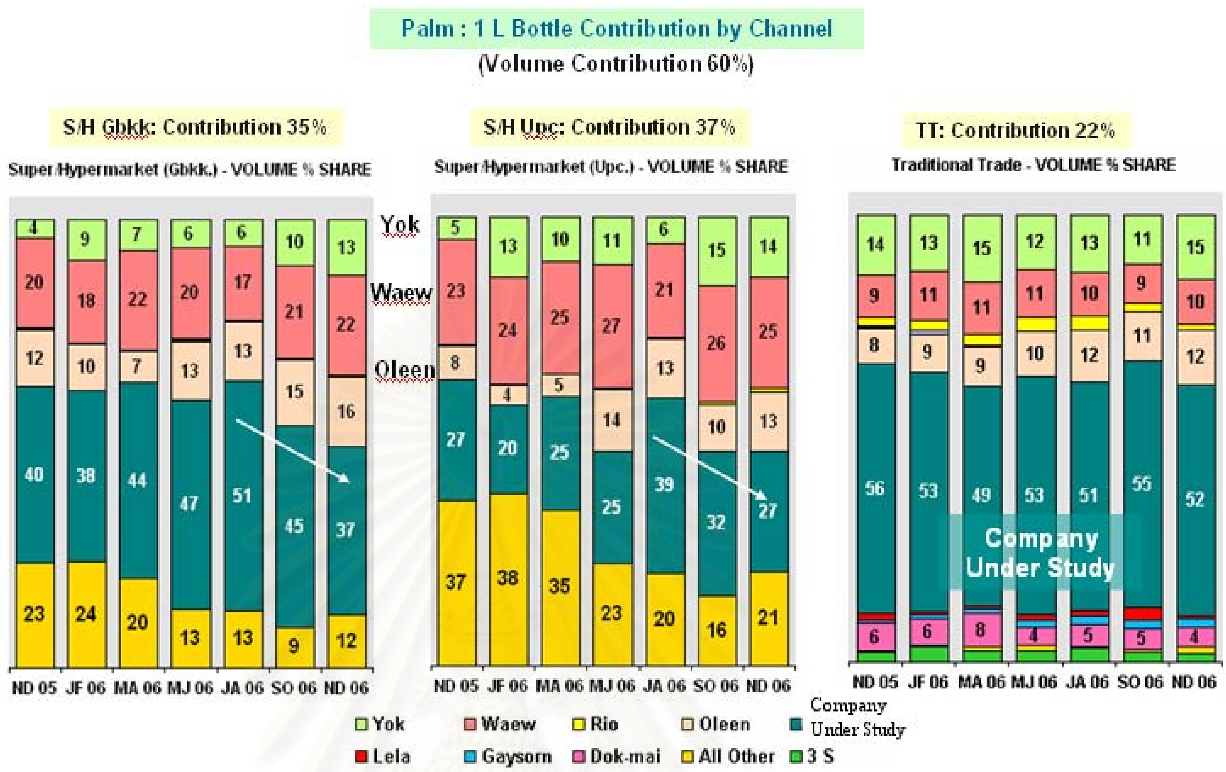

Figure 3.7 Palm 1L Bottle Channel Contribution   Source: Nielsen, 2007

3) Market Opportunity Available

There are 2 aspects that need to be looked at for market opportunity. They are the demand of the market and the price of the market.

Demand

The data collected in Table 3.1 shows the number of cases of 1 litre palm oil sold monthly from the year 1996 up until 2005. Figure 3.8 shows the number of cases sold yearly from 1996 until 2005.

Table 3.1 1L Palm Oil Cases Sold Monthly   Source: Morakot, 2006

Month	Number of 1 Litre Palm Oil Cases Sold Monthly (1996-2005)									
	Year									
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
January	176438	196391	137985	174440	179938	175263	229531	112033	196277	249364
February	131978	105894	148150	169946	141705	214909	181099	260595	210092	227703
March	162932	210817	116633	114849	176268	243282	255216	239398	208725	295707
April	178702	207110	148930	182635	137663	197984	197284	228746	209351	260737
May	179839	183016	194005	166749	182474	281036	255871	246538	229101	232274
June	159857	170039	174857	166817	122505	229281	172288	241726	257000	265373
July	183446	160028	122994	158834	98368	268236	255931	198559	217029	203749
August	181336	206548	139319	153272	145492	159188	256378	256872	238143	221364
September	156409	113506	201103	120238	67412	169035	238139	253064	199911	219110
October	187635	157892	136771	124336	186251	264835	239463	205646	191527	229921
November	160947	179539	98132	229179	185746	223705	181990	117692	209695	201754
December	179180	194526	176145	268606	183933	198545	86111	182608	224586	184486

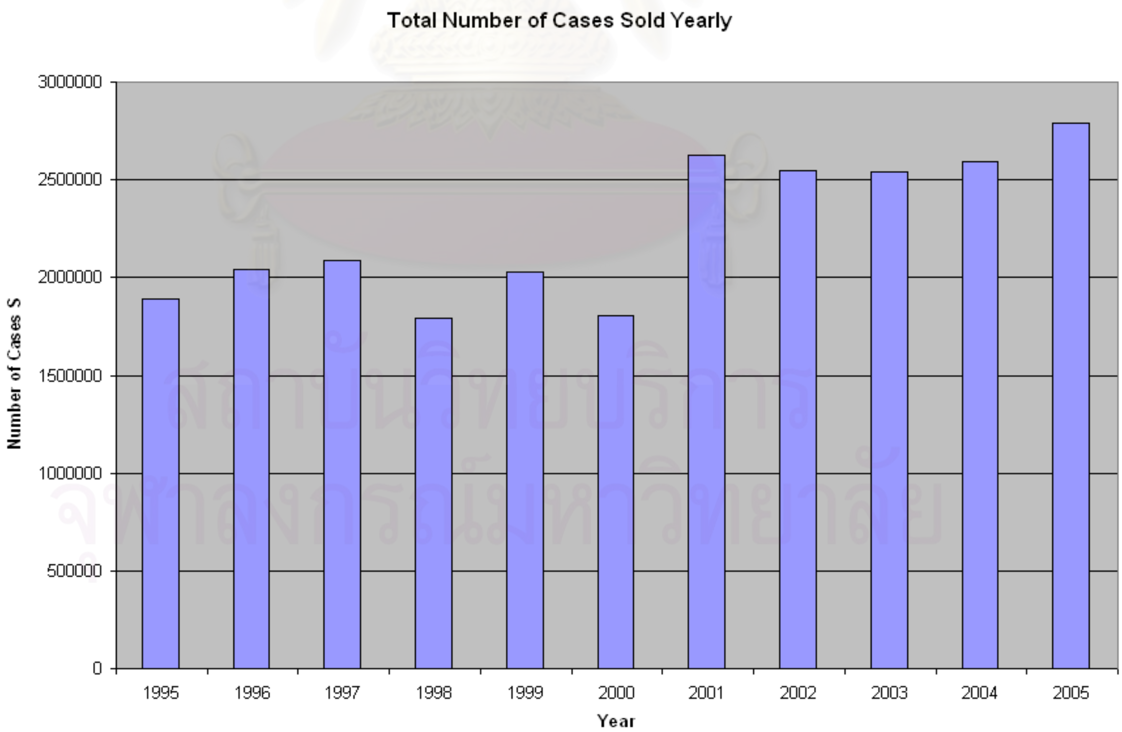

Figure 3.8 1L Palm Oil Cases Sold Yearly

From the graph shown in Figure 3.8 above, from the year 1996 up until year 2000 there has been a steady sale of the 1 litre bottle cases. However starting from the year 2001 up until 2005 it shows there is a sharp increase in sales volume over the years. From the data obtained above we can then forecast future demands for the 1 litre palm oil bottle for the company.

Price Fluctuation

According to Figure 3.9 sales volume shows that there has been a steady increase since 1999 from 36,504 MT up until to 57,131 MT. This shows that the current machine has reached is full capacity of production to fulfill the demand. Figure 3.10 shows the margin per MT for the various segment of the market. The margin is constantly changing over the years to due the fluctuating price of the crude palm oil world market.

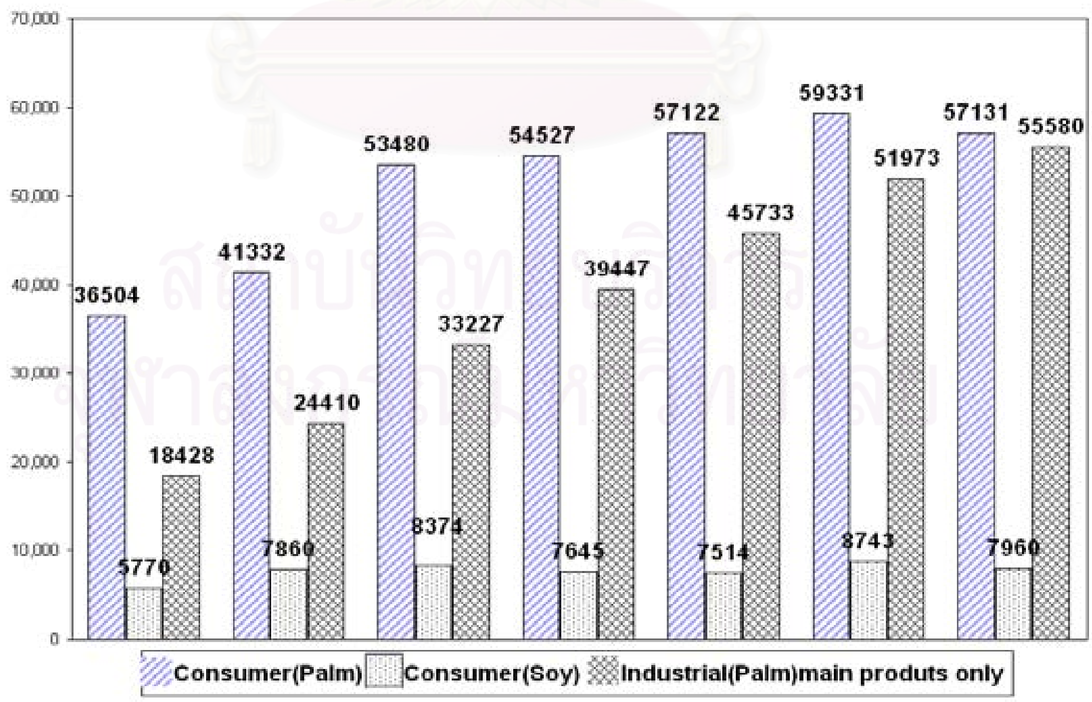

Figure 3.9 Sales Volumes in MT Source Morakot, 2006

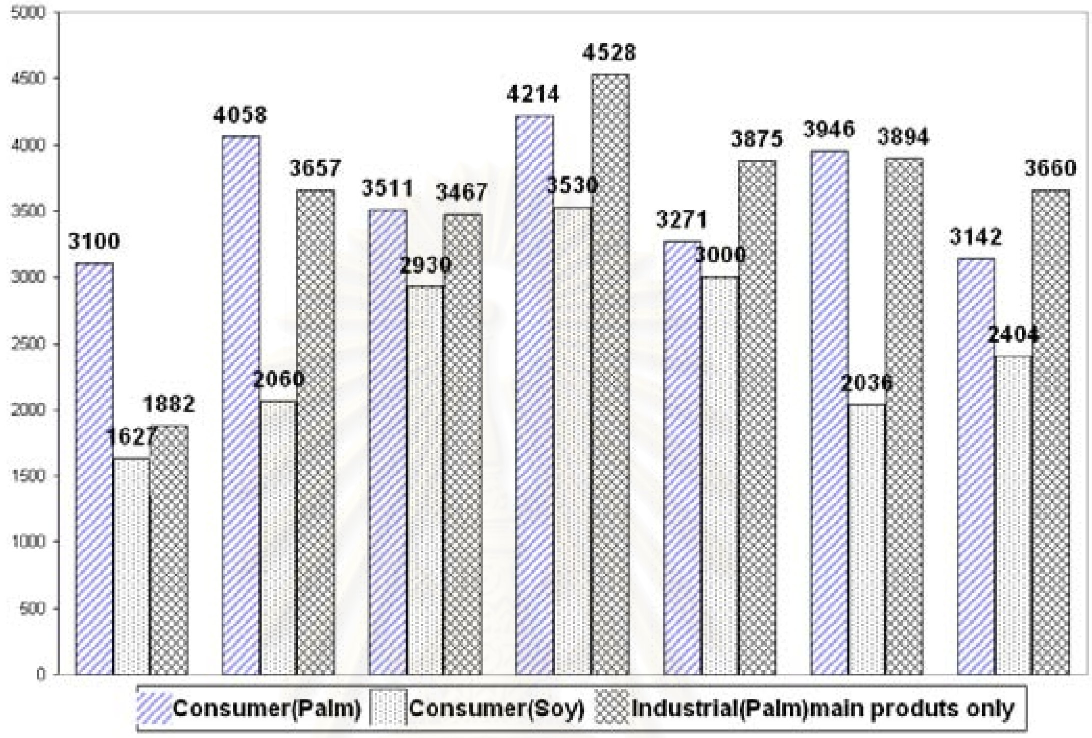

Figure 3.10 Margins per MT   Source Morakot, 2006

From the data shown above there is a need to increase machine capacity to increase sales. This is because the data shows that the sales volume has reached its peak and resulting in a lower margin per MT as well as loss of market share in terms of opportunity costs.

4) Meeting the Needs of the Market

To meet the needs of the market we need to identify the marketing strategy. Part of the market strategy is to take advantage of the growing market opportunity. This is done by improving or increasing the production capacity to increase sales. Also as the demand of the market per year is seasonal, the company under study would not hold much finished goods inventory except for bumper stock only. Hence during low demand season, the machinery is expected to run about 65% production of the peak production during the first year. This would reduce inventory as wells as meet the needs of the market.

5) Expected Improvements of Market

The expected improvements of the market will look at the forecasted demand and with that information, the planned utilization and planned expansion are identified.

Forecast Demand

Utilizing the data in Table 3.1, we can then estimate the peak future demand for number of cases of the 1 litre palm oil bottle. Looking at Figure 3.8 there has been a steady market growth since 1996. Hence the forecast shown below takes into account the growth rate for the next 4 years for the 1 litre palm oil bottle. The company plans to meet these forecasted demands. There are several techniques involved with forecasting and one of the techniques is linear regression forecasting. This technique involves one independent and one dependent variable to form the linear regression (Wikipedia (2), 2008). Using statistical data that are available, a linear combination is drawn by observing the statistical data (Wikipedia (2), 2008). The technique used for forecasting below is the linear regression technique.

Table 3.2 Demand forecast for 1 litre bottle palm oil

	Forecast 2007	Forecast 2008	Forecast 2009	Forecast 2010
Cases/month	241,340	267,890	281,228	294,748
MT/ year	31,828	35,329	37,088	38,971

Table 3.3 Forecast for sales and contribution of various bottle sizes

	Forecast 2007	Forecast 2008	Forecast 2009	Forecast 2010
Sales in MT	56,639	62,870	66,000	69,173
Contribution in Baht Million	242.8	261.6	279.4	293.4

Planned Utilization

By looking at the forecast peak demand for cases per month, assuming the maximum capacity of the machinery is at about 300,000 cases per month, the improved machinery would be utilized at an average of 80% in the first year and 90% in the second year. Subsequently 93% in the third year and near 100% by the fourth year.

Planned Expansion

Hence by the fourth year, with the peak demand reaching the assumed maximum capacity, this would be the appropriate time to purchase another similar machinery to fulfill the market demand after the fourth year. This would then double the capacity of the company under study.

Summary

There is a steady growth of demand for the product over the past years, this because of the growing market and effective marketing. The steady demand of growth has resulted the current machinery to reach is full capacity and hence some opportunity loss. Also looking at the forecasted demand for the product shows that this growth would remain over the years. Therefore from the marketing feasibility point of view it would be better to increase the production capacity of the machinery in order to meet the growing demand.

3.9 Technical Feasibility

The technical feasibility was conducted to determine the requirements to meet the capacity requirements as determined in section 3.8. The technical feasibility will cover 5 technical areas of the machine replacement process. The 5 areas are the expected capacity, labour required, amount of electrical power required, physical dimensions of the machine, and plant layout.

3.9.1 Expected Capacity

The current capacity of the existing machinery is about 180,000 cases per month or about 2,160,000 bottles per month. The expected capacity of purchasing new machinery or by upgrading the existing machinery has to be about 290,000 cases per month or 3,600,000 bottles per month.

3.9.2 Labour Required

The existing machine line that is used currently incurs a very high cost. It consists of 3 filling machines that are labour intensive. That is 8 line workers per shift for 3 shifts; these workers are needed for 25 days per month for 12 months with an average salary of 5,000 Baht per month. The total current number of workers required is at about 270 workers, this includes workers from activities such as transporting goods, inventory checking, goods handling among others. However upon machine replacement, the requirements for labour would be reduced as the line would be mostly automated. That is 3 line workers per shift for 3 shifts. The total number of workers required would then be reduced to about 120 workers.

3.9.3 Electrical Power Required

For the SIPA machine, the integrated ECS machine (FX 20/64) and linear blowing machine (SF 2/2) has an average absorbed power of 200 kW and 25 kW respectively. However the average absorbed power is also needed for the different parts of the integrated machinery such as air conditioning unit, cooling system and blowing air systems. This is as shown below for the average absorbed power during worst conditions.

Table 3.4 Average Absorbed Power for SIPA Source: SIPA, 2004

Description	Absorbed Power (kW)
ECS FX 20/64	200
SF 2/2	25
Dryer PET (Integrated machine)	45
Air conditioning unit for cabin (Integrated machine)	25
Cooling system (Integrated machine)	150
Blowing air system (Integrated machine)	209
Total	654

For the ASB upgrade machinery, the average absorbed power is about 1071.5 kW under worst conditions. Below are the details for the average absorbed power including different parts of the machinery.

Table 3.5 Average Absorbed Power for ASB Source: ASB, 2006

Description	Absorbed Power (kW)
PB 170/170 B 2/8	386
Dryer PET (Integrated machine)	103
Cooling system (Integrated machine)	267.5
Blowing air system (Integrated machine)	315
Total	1071.5

From the view point of the average electrical power required the SIPA machine requires less average absorbed power by about 40% and hence may translate to more savings. The ASB upgrade machine requires more electrical power due to inefficiencies within the machinery.

3.9.4 Physical Dimensions of the Machine

As the SIPA machinery mentioned earlier has two major parts to it, the physical dimensions have to be separated. This is as shown below.

Table 3.6 Physical Dimensions of the SIPA Machine Source: SIPA, 2004

Description	Units	Measurement
ECS FX 20/64 (Blow Mold PET)		
Machine Dimensions LxWxH	m.	17x4,6x3,5
Machine Weight (dry)	Kg.	78,000
Hydraulic unit oil charge	Dmc.	2,200
Total Weight of ECS FX 20/64	Kg.	80,000
SF 2/2 (Resin Hopper/Feeder)		
Machine Dimensions LxWxH	m.	3,8x1,85x3,2
Machine Weight (dry)	Kg.	2500
Hopper and perform ranger weight	Kg.	450
Cabin Weight	Kg.	450
Total Weight of SF 2/2	Kg.	3400
Total Weight	Kg.	83,400

Table 3.7 Physical Dimensions of the ASB upgrade Machine Source: ASB, 2006

Description	Units	Measurement
PB 170/170 B 2/8 (Blow Mold PET)		
Machine Dimensions LxWxH	m.	11,8x3,4x3,5
Machine Weight	Kg.	33,000
Hydraulic unit oil charge	Dmc.	1590
Total Weight	Kg.	34,590

Table 3.8 Physical Dimensions of conveyor, filling, packing   Source: SIPA, 2004

Description	Units	Measurement
Filling Machine		
Machine Dimensions LxWxH	m.	10,5x6x2,2
Capping, Labeler, Case Packer Machine		
Machine Dimensions LxWxH	m.	59x6x2
Total Machine Weight	Kg.	2500

Knowing the technical specifications shown above, and adding the space required for the entire machinery which includes the conveyor, filling, and packing can then be estimated.

3.9.5 Plant Layout

The plant layout in Figure 3.11 shown below is the layout for the existing 1 Litre palm oil in bottle line and in Figure 3.12 shows the new 1 L bottling line upon machine replacement.

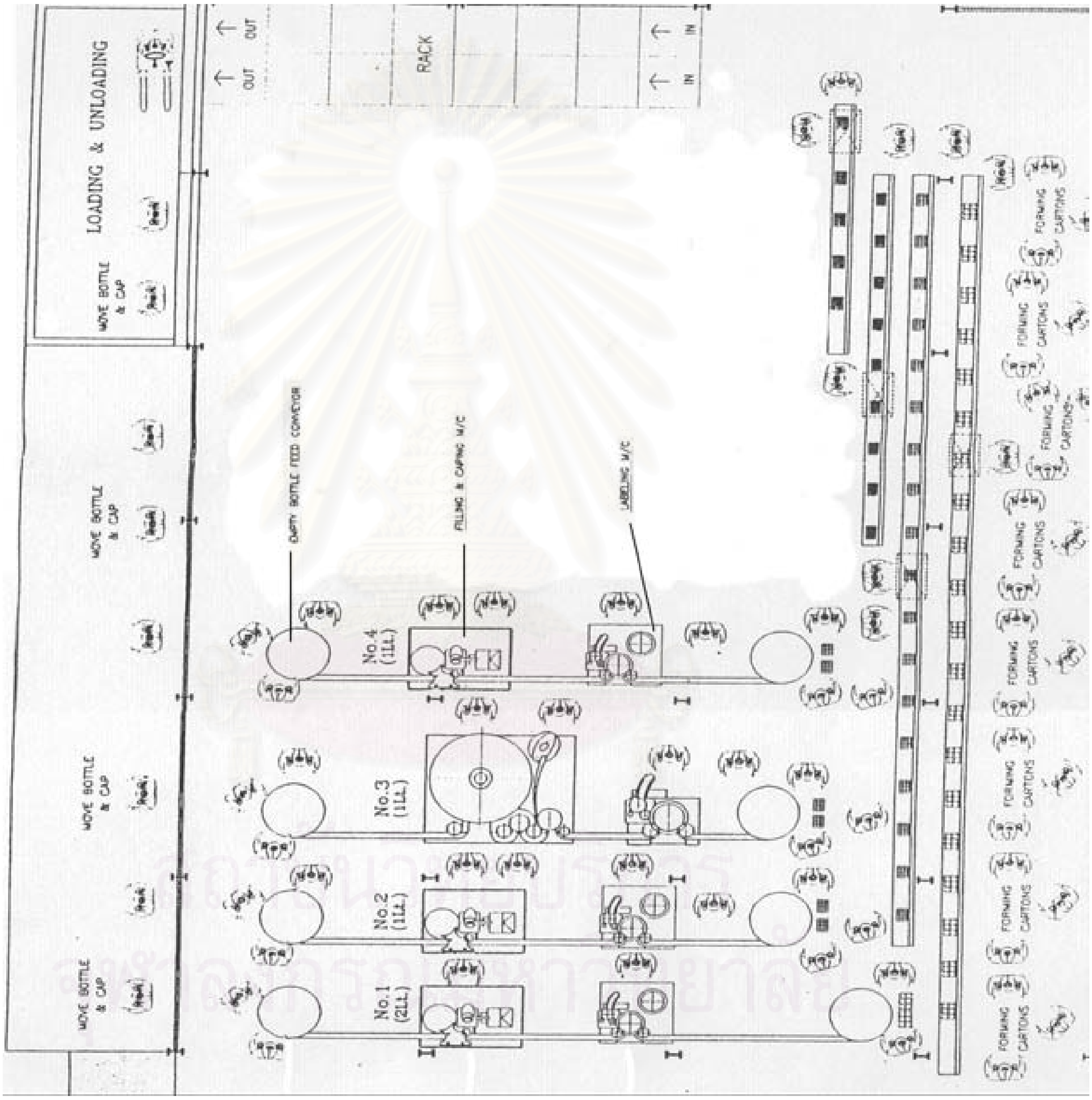

Figure 3.11 Existing Plant Layout

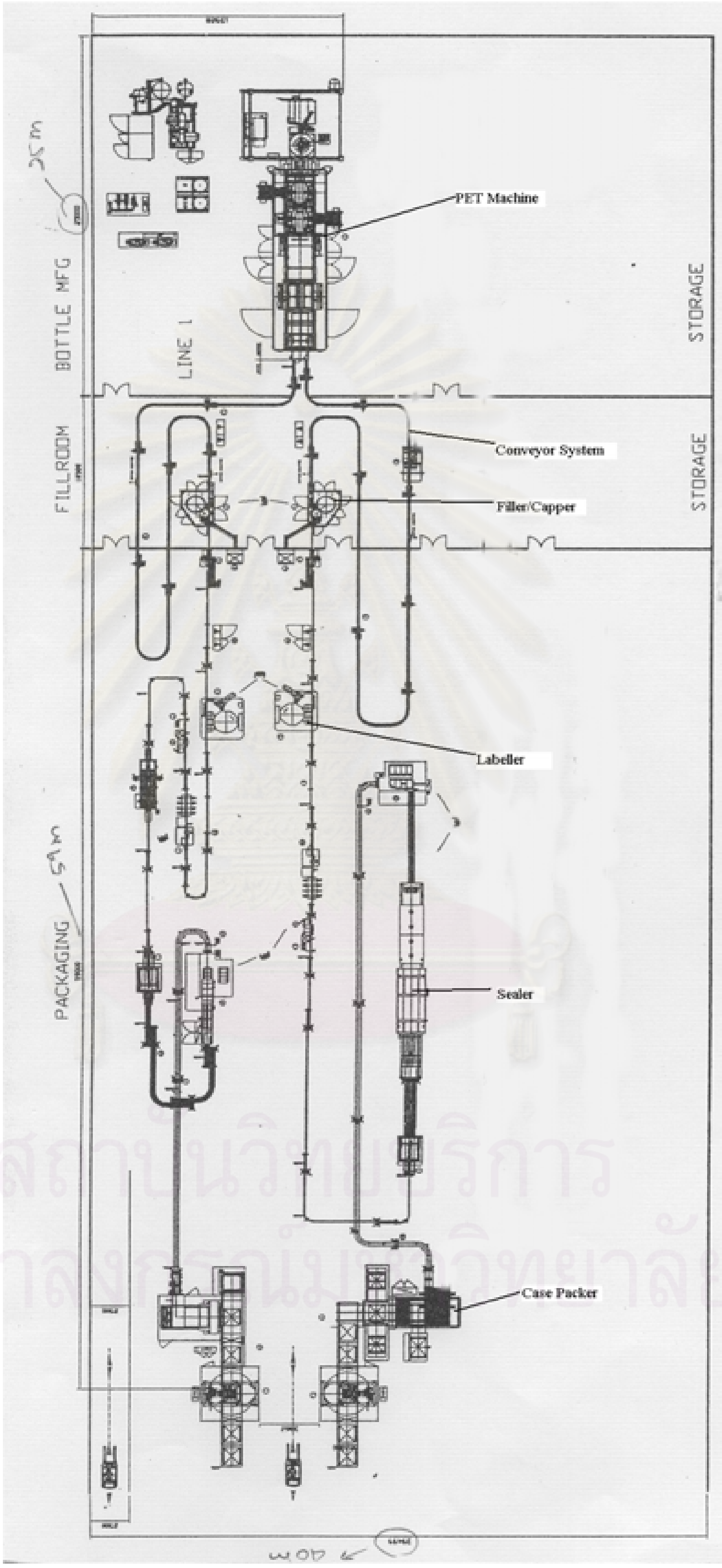

Figure 3.12 New Plant Layout After Improvement

3.9.6 Summary

Looking at the expected capacity, the SIPA (Option 2) and ASB (Option 3) machine is well suited to achieve the desired capacity. Looking at other factors like the labour requirements shows that there is savings to be had upon improving the existing machinery. The electrical power required for the SIPA machine is lower than that of the ASB machine, however in terms of weight size the ASB machine is more flexible in comparison with the SIPA machine.

3.10 Financial Feasibility

The financial feasibility was conducted to compare the alternative to support selection. As the company's factory is situated in Samut Prakan, the Board of Investment Thailand (BOI) has identified it as one of the many investment zones in Thailand. There are several financial issues that need to be looked at regarding the incentives that are offered by BOI. The first issue is the taxation issue, where it states that the corporate income tax can be exempted for up to 3 years given that the investment is more than 10 million baht or by obtaining international standard certification (BOI, 2007). Otherwise the taxation is only valid for 1 year (BOI, 2007). The company under study does not qualify for the tax exemption because the incentive only applies for new start-up companies (BOI, 2007). Another issue to look at is the import duty. There is a 50% import duty reduction for new imported machinery that is not less than 10% of the import duty (BOI, 2007). Also there is an import duty exemption for imported raw materials for products that are used for export (BOI, 2007). However the company under study is not eligible for the import duty incentive because the import duty for the machinery is less than 10%. Also the raw materials that are used would not be imported for use by the company.

The financial feasibility will cover the financial analysis for the options available. That is EUAC, Savings, and Source of Funds. The measures chosen above are viewed as alternatives as each measure have its own advantages and disadvantages. This would allow for advantages of one measure be able compensate the disadvantage of another measure.

3.10.1 Cash Flow Analysis

The cash flow analysis shows the savings from the cost per bottle and labour. As the new machine will require fewer raw materials and also better efficiency in the production of the bottles. Each case contains 12 individual bottles. The packing labour, bottle, cap, carton, and labour show the cost breakdown in baht per kg of a case of cooking oil. The packing labour is reduced because the labour requirements of the machine have been reduced. The bottle cost shown includes the processing cost such as resin material and energy. The cap, carton, and label are outsourced. Knowing the cost per case the individual cost per bottle can be calculated.

Table 3.9 Breakdown of Forecasted Savings Per Case

	Current Cost Per Month for 1 Case (Baht/kg)	Planned Costs Per Month for 1 Case Upon Machine Improvement (Baht/kg)
Packing Labour	3.1	1.20
Bottle (inc. processing cost)	26.4	15.24
Cap	8.40	8.76
Carton	6.0	7.32
Label	0.7	1.56
Total Cost Per Case	44.60	34.80
Total Cost Per Bottle	3.72	2.9

Table 3.10 Forecasted Savings

	Number produced per month	Current cost	New cost	Savings per month (million baht)
I Litre Cases	300,000	44.6	34.80	2.940
1 Litre Bottles	3,600,000	3.72	2.9	2.952

Another cash flow analysis is the saving from labour that is the new replacement machine will require less manual labour than the existing machine. The reduction of labour is expected to be about 150 workers. Hence the number of workers is multiplied with salary per year to obtain savings per year.

Table 3.11 Forecast Savings from Labour

Number of workers	Salary per day (baht)	Number of days	Number of months	Savings per year (million baht)
150	200	25	12	9.0

3.10.2 Source of Funds

As the company under study is a strategic business unit in Thailand, the source of funds for investment is obtained from the parent company. This is because the company under study has a good reputation in Thailand and also the parent company is willing to invest further so as to expand the business. Also the company under study has been in business for many years and have retained profits during those years hence the funds to invest in the machinery can also be obtained from the company itself. From the analysis of the cash flows resulted from each alternative, the company has no problem in financing any alternative.

3.10.3 Equivalent Uniform Annual Cost (EUAC)

A EUAC analysis is first done. There are three options available for the company. They are to keep the existing machine for another few years and purchase the bottles that cannot be made with its capacity from bottle makers (Option 1), replace the old machine with a new one (Option 2) or upgrade the existing machinery (Option 3). Below shows the equivalent uniform annual cost (EUAC) analysis using a study period of 10 years in million baht. The annual expenses is derived from the sum of operating cost, depreciation and, and insurance.

Table 3.12 EUAC Analysis

	Existing Machine (Defender, Option 1)	New Replacement (Challenger, Option 2)	Upgrade Replacement (Challenger, Option 3)
Capital Investment	25.30	111.72	182.28
Operating Cost			
Material	96.422	125.28	125.28
Energy	8.93	10.67	16.5
Labour	1.62	0.54	0.54
Maintenance Cost	37.00	2.25	4.00
Depreciation	0	11.17	18.23
Insurance	0.10	7.82	12.76
Purchased Bottles	86.314	-	-
Annual Expenses	230.39	157.73	177.31
Estimated Market Value after 10 years	3.70	33.52	63.80
Cost Per Year	4.86	20.62	33.18
Total EUAC (15%)	235.25	178.35	210.49

Looking at the total EUAC, the new replacement machine (Option 2) has a smaller EUAC than upgrading (Option 3) or keeping the existing machine (Option 1). Hence therefore based on the EUAC analysis it is justified to replace the existing machine with a new replacement (Option 2).

3.10.4 Summary

The financial criteria in this case would be the EUAC and Source of Funds. By comparing the two machine options together, and considering the needs of the company under study. The better option to choose is Option 2, by replacing the existing machinery with a totally new machine.

Since Option 1 is the most expensive, does not solve other operational inefficiency problems, and does not have any advantage over the other options, it will not be considered any further for analysis.

3.11 Intangible Consideration

There are three main types of blow molding techniques, they are stretch blow molding, extrusion blow molding, and injection blow molding (Wikipedia (1), 2008). The stretch blow molding technique involves molding the plastic into preform first and then cooled down. After this is done the preform is then reheated and blown into full sized bottles (Wikipedia (1), 2008). This technique is widely used for Polyethylene Terephthalate (PET) plastic bottles for mass production (Ebottles, 2007). Extrusion blow molding involves a hollow tube at which the plastic is melted and then extruded into the hollow tube by compressed air (Wikipedia (1), 2008). Injection blow molding is similar principal to that of the stretch blow molding technique. The injection blow molding involves a rotating pin within a molding station that is rotated while being inflated and then cooled (Wikipedia (1), 2008).

Apart from financial comparison, several intangible factors were considered in the replacement selection. Weighted scoring was used to analyze overall justification of options based on important selection criteria. Table 3.15 shows the weighted scoring process. There were five major factors that were considered. Supplier reliability and maintenance were the most important. Next was capacity and operating cost. Flexibility was also an important factor.

From the technical feasibility point of view, the ASB machine (Option 3) has a lighter weight and smaller size compared to the SIPA machine (Option 2). However the power consumption of Option 3 is much larger and may translate to more cost in the future for the company. As the size of Option 3 is smaller, this may only provide a small advantage for the company as the cost of power consumption is too high. The financial feasibility shows that Option 2 has the advantage financially over Option 3 because Option 2 is a new replacement machine. Looking at all the results of the three areas of feasibility study, the SIPA machine (Option 2) has shown that it is more economically and technically suitable for the company needs than the ASB upgrade machine (Option 3) option.

Table 3.13 Weighted Scoring for Replacement Options. (Rating Ranges from 1 to 4)

		New Machine (Option 2)		Upgraded Machine (Option 3)	
Factors	Weight	Rating	Weighted Score	Rating	Weighted Score
Supplier Reliability	25	3	75	3	75
Maintenance Coverage	25	4	100	2	50
Capacity	20	4	80	4	80
Operating Cost	20	3	60	1	20
Flexibility	10	1	10	2	20
Total			325		245

The new replacement machine (Option 2) had several advantages. Firstly, the supplier was well known and had a good reputation for its service. Second, it had the flexibility to change bottle sizes when needed. Thirdly, the supplier would provide much longer maintenance coverage of 10 years for the machine. The only advantage of the upgraded machine (Option 3) was that it was familiar to work with and did not require much additional training. The technology used by Option 2 is based on the stretch blow molding technique.

3.12 Replacement Selection

From the analysis of market, technical, and financial analysis shows that Option 2 is the better option available. Also considering the intangible factors, Option 2 is again the ideal selection. Therefore the company selected the new machinery (Option 2) by the supplier SIPA.

Chapter IV
Project Implementation

After selecting the machinery in chapter 3, this chapter will identify the actual implementation of the machinery and the issues that are associated with it. Because by knowing what issues are involved and detailed feasibility study in the previous chapter, the planning for implementation can then be realized. This chapter will cover the planning implementation of the selected machinery, identify the risks involved during implementation and mitigation solutions. Knowing the results of the implementation we would know if the selected machinery was the right machinery for the company under study. This chapter also contains the actual results of the performance of the selected machinery and as well as an analysis of how effective was the implementation.

4.1 Risks Issues

There are several risks issues that need to be identified and mitigated for the implementation of the machinery. Table 4.1 shows the risks issues assessment with rated likelihood and impact. The most significant risk was the disruptions that might occur to existing operations during implementation. The best solution was to keep the operations running at a certain level so as to allow for the new machinery to be installed at the same time. This issue could be mitigated further by having proper planning by the supplier and the company involved.

The second issue was the project time delay. The project might consume more time than intended. This issue could be solved by allocating extra days for the project and to have the supplier responsible for any significant delays.

The third issue was the accidents that could occur during the construction and execution phase of the project. Arrangements would be made for the contractor to be responsible for those that would happen.

The fourth issue is the complaints from residents nearby. To mitigate this issue, the company has to inform the residents beforehand and allocate monetary compensation for any damages that might occur.

There were two minor issues that have a high probability but low impact. These were lack of training and technical problems. As the machinery would be new, the workers lack the adequate training to operate the machine properly. To mitigate this problem appropriate training was provided to be able to operate the new machinery. Incentives were provided where appropriate.

Table 4.1 Risks Issues Assessment

Risks	Likelihood	Impact	Priority score (Likelihood*Impact)
Disruption to existing operations	5	5	25
Project time delay	4	5	20
Accidents occurring during construction and execution	5	3	15
Complaint from residents	3	4	12
Lack of training	3	1	3
Technical problems	5	1	5

4.2 Work Planning

The scheduled work plan is shown on the next page with the appropriate tasks to implement the machinery. The total time for the implementation is about 1 year.

ID	Task Name	Duration	Start	Finish
1	**Machine Implementation Project**	**310 days**	**Mon 3/29/04**	**Fri 6/3/05**
2	**Main Building Construction**	**235 days**	**Fri 5/21/04**	**Thu 4/14/05**
3	Plan Submission/Permit Approval	40 days	Fri 5/21/04	Thu 7/15/04
4	Mobilisation	5 days	Fri 7/16/04	Thu 7/22/04
5	Piling Works	40 days	Fri 7/23/04	Thu 9/16/04
6	Main Building Works	150 days	Fri 9/17/04	Thu 4/14/05
7	**Base Built Machine & Equipment**	**220 days**	**Mon 5/31/04**	**Fri 4/1/05**
8	Contractor Pre-Qualification	10 days	Mon 5/31/04	Fri 6/11/04
9	Prepare Bid Document	10 days	Mon 6/14/04	Fri 6/25/04
10	Bidding	10 days	Mon 6/28/04	Fri 7/9/04
11	Tender Interview & Negotiation	5 days	Mon 7/12/04	Fri 7/16/04
12	Mobilisation	5 days	Mon 7/19/04	Fri 7/23/04
13	MEP Works	160 days	Mon 7/26/04	Fri 3/4/05
14	Testing & Comissioning	20 days	Mon 3/7/05	Fri 4/1/05
15	**PET Equipment Orders**	**289 days**	**Mon 3/29/04**	**Thu 5/5/05**
16	Equipment Vendors Pre-Qulification	20 days	Mon 3/29/04	Fri 4/23/04
17	Bidding & Negotiation	4 days	Mon 4/26/04	Thu 4/29/04
18	Tender Interview & Clarification	5 days	Fri 4/30/04	Thu 5/6/04
19	**Equipment Fabrication, Ship to site**	**220 days**	**Fri 5/7/04**	**Thu 3/10/05**
20	PET Blowing Machine	220 days	Fri 5/7/04	Thu 3/10/05
21	Certified Equipment Drawings	20 days	Fri 5/7/04	Thu 6/3/04
22	Other Filling, Labeling & Packing Equipment	150 days	Fri 5/7/04	Thu 12/2/04
23	**Equipment Installation**	**110 days**	**Fri 12/3/04**	**Thu 5/5/05**
24	PET Blowing Machine	30 days	Fri 3/11/05	Thu 4/21/05
25	Other Filling, Labelling & Packing Equipment	30 days	Fri 12/3/04	Thu 5/5/05
26	**Process Piping**	**181 days**	**Thu 7/15/04**	**Thu 3/24/05**
27	Contractor Pre-Qualification	10 days	Thu 7/15/04	Wed 7/28/04
28	Prepare Bid Document	10 days	Thu 7/29/04	Wed 8/11/04
29	Bidding	10 days	Thu 8/12/04	Wed 8/25/04
30	Tender Interview & Negotiation	6 days	Thu 8/26/04	Thu 9/2/04
31	Mobilisation	5 days	Fri 9/3/04	Thu 9/9/04
32	Process Piping Works	26 wks	Fri 9/10/04	Thu 3/10/05
33	Testing & Comissioning	2 wks	Fri 3/11/05	Thu 3/24/05
34	**Completion**	**21 days**	**Fri 5/6/05**	**Fri 6/3/05**
35	Overall Setup & Comissioning	20 days	Fri 5/6/05	Thu 6/2/05
36	Handover	1 day	Fri 6/3/05	Fri 6/3/05

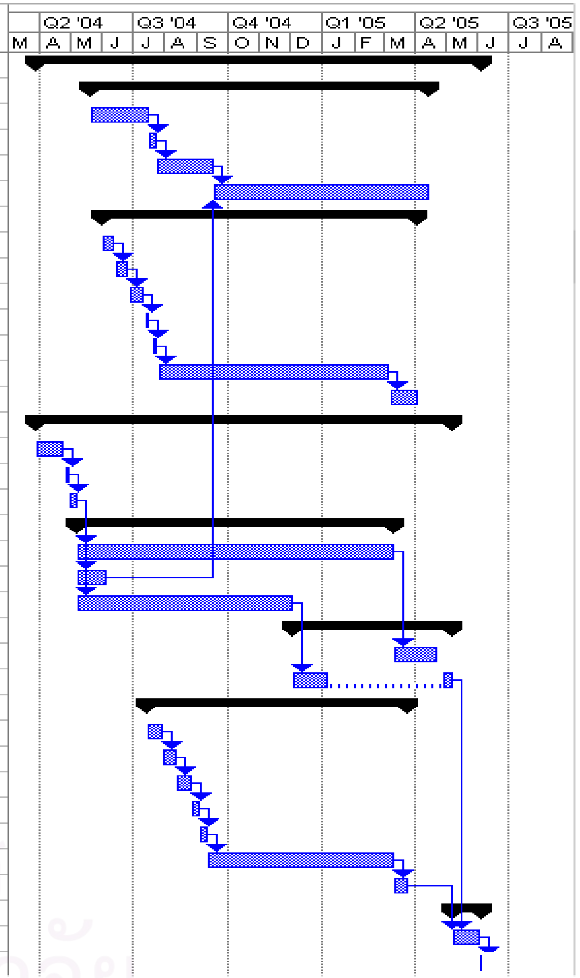

Figure 4.1 Work Plan Schedule Source: Morakot, 2007

The work plan schedule consists of 5 parts which are main building construction, base built of machine and equipment, PET equipment orders, process piping, and completion. The main building construction involves constructing the building to house the new machinery where as the base built indicates building the foundation for the PET machine. The main building construction consists of several parts that are plan approval, mobilization, piling, and main building works. As the size of the machine is quite large, the base structure such as the housing room has to be ready first for the machine to move in then only the other parts of the structure is completed. Machine, Equipment and Piling (MEP) works would take about 160 days, after that the testing and commissioning of another 20 days. The selected machinery is ordered before hand to allow time for equipment fabrication and construction of the main building. This would require 220 days. When the machine arrives, it is then installed together with the PET machine, filling, labeling, and packing equipment which would take about 110 days. Once the process piping has been completed, the overall setup and commissioning can begin. The total length time for the project to be completed is expected to be at 310 days.

4.3. Project Monitoring and Control

Project monitoring and control involves identifying the problems that occurred during the implementation process. Knowing the problems that occurred, the solutions that was implemented can than be analysed.

4.3.1 Problems Occurred

There were several problems that occurred during the implementation process. One of the main problems is the people. The people involved with operating the machinery did not have adequate technical know-how to operate the new machinery.

This was because the new machinery is more technologically advanced and hence requires a certain degree of technical know-how. Adding to this problem is also the lack of the right people and training to operate the new machinery.

Another problem is the technical problems that occurred. One such problem was getting the right glue for the case packer machine to use. If the glue dried too fast then the box would not stick together where as if the glue takes too long to dry, the box would not be rigid enough to be transported. Another technical problem was the breakdown of some of the components of the machinery such as the touch screen. This was partly caused by the warm and humid climate. Also when testing the filling, labeling, and packing equipment the rate of production of each part was different. Hence synchronization among different parts of machinery was required. The problems mentioned above caused some delays to the project itself. However there were several solutions implemented to cope with these problems.

4.3.2 Solutions Implemented

To solve the problems outlined above several solutions measures was implemented to try and reduce the impact of the problems. Firstly, the people problem was solved by providing appropriate training so as to be able to operate the new machinery. Also more time is allocated for training while providing incentives for workers to attend the training. Incentives include better wages for trained workers. Hiring the right people is also important so as to be on par with the basic technical knowledge that is required.

Most of the technical problems that occurred were handled by the supplier as the components were replaced immediately to save time. The solution for the synchronization problem and the delay that resulted from the technical problems is to have an allowance of extra number of days to the work schedule. Also if there were any further delay, then the supplier would have to compensate monetarily to the company under study.

4.4 Results

The results would consist of 3 different parts that are collection of results, implementation measures, and performance measures.

4.4.1 Collection of Results

After the implementation, testing, and commissioning of the selected machinery, the implementation and performance measures were then collected from the 1 litre palm in bottle line. The implementation measures will consist of the number of days delayed, rated speed of the machinery, and cost involved due to the delay. Where as the performance measure will measure the capacity achieved during peak and non-peak times, number of labour utilized, and actual cost incurred per case.

4.4.2 Implementation Measures

After including the extra number of days allocated to the project, the project still suffered a delay of about 60 days. Because of the delay there was some opportunity cost lost which were about 120,000 cases per month for 2 months or about 2.94 million baht per month. However the company under study was compensated 2 million baht for the delay by the supplier. When the overall and testing of the machine was completed the rated speed of the new machinery was rated at 300,000 cases per month at 100% efficiency.

4.4.3 Performance Measures

As the demand is seasonal and varies with the months, the actual achieved capacity of the new machinery is at 240,000 cases per month during the non peak period where as 290,000 cases per month during the peak period. The number of workers utilized was at 120 workers. The table below shows the actual cost incurred per case. The technology that was used by Option 2 is based on the stretch blow molding technique which results the lower cost of the bottles. This is also because the new technology uses less resin when manufacturing the bottles. The cap, carton, and label cost is fluctuating to due to petroleum cost prices. Furthermore, the cap, carton, and label are outsourced. Again knowing there are 12 bottles per case as mentioned earlier the total cost for an individual bottle can be calculated.

Table 4.2 Actual Cost Incurred Per Month for 1 Case

Actual Cost Incurred Per Month for 1 Case	First Month (Baht/kg)	Second Month (Baht/kg)	Third Month (Baht/kg)
Packing Labour	1.20	1.20	1.20
Bottle (inc. processing cost)	15.2	16.1	17.7
Cap	8.8	8.8	8.52
Carton	8.0	6.7	7.33
Label	2.3	2.2	2.4
Total Cost Per Case	35.5	35.0	37.15
Total Cost Per Bottle	2.96	2.92	3.1

4.5 Effectiveness of Implementation

Looking at the implementation measures shows that overall the project was delayed by 2 months. This led to lost of opportunity cost but was mostly compensated by the supplier. With the synchronization of the new machinery the rated speed was at 300,000 cases per month at 100% efficiency. The performance measures show that the capacity achieved is inline with the rated speed of the machinery during the peak period. Despite the delays that occurred, the implementation is still fairly effective because the objective of cost savings and implementing new machinery was achieved.

4.6 Discussion

The actual cost incurred per month for 1 case as shown above, shows that the actual cost is very close to the predicted cash flow analysis in Chapter 3. However there are several fluctuations between the three months of the cost incurred. The packing labour has remained the same but the bottle cost is increasing due to rising resin prices. Also the cap and label cost is fluctuating but have remained about the same throughout the 3 months of data. The carton cost was very high in the first month as the box packing machine had some technical difficulties and repacking of the boxes had to be done. Overall looking at the actual cost incurred of three months shows that it is very near to the predicted cost in chapter 3.

Chapter V
Conclusion, Discussion and Recommendations

This project started initially by identifying the problems that was plaguing the company under study. The requirements to solve the problems were then identified. A conceptual framework for machine replacement was found based on existing and relevant theories. This framework consists of mainly market, technical and financial feasibility that was applied to the company. By doing the feasibility study the most appropriate machine was identified by justification among the various options that was available to the company. The actual results after the implementation was then compared with theoretical results and found that there were similarities. This showed that the chosen machinery was the best one for the company under study despite slight differences between the theoretical and actual results. Drawing from all of the analysis from chapter 1 to chapter 4, this chapter will include the conclusion and conceptual framework for this report. Also the recommendations will include the scope of the next phase and expansion to other businesses. This will be based on the lessons learned from the project. From the conclusion, discussion, and recommendations, a recommendation for the next phase is made for further future work.

5.1 Conclusion

The planning and implementation of the replacement bottle making machine has increased the production capacity by almost 50%. The double handling within the process flow was also eliminated as shown in chapter 3. With the improvement of the process flow, the bottleneck occurrence has been reduced due to the increased production time. The production cost has also been reduced by 20% due to the implementation of the new machinery.

The various options available is looked at individually and then analyzed with feasibility analysis to come up with the best option for the company under study. From the feasibility analysis that was done earlier in the previous chapters, it was found that for the market feasibility, there is a growing market over the years for the product. However the margins and market share for the company has decreased due to the production capacity constraint that is unable to meet the growing demand of the product which resulted in sales opportunity lost. Also due to this increasing demand, the current machinery has reached its full capacity and requires replacing. The market forecast expects the demand to grow up to nearly 300,000 cases per month within 3 years from 240,000 cases per month. Hence another planned expansion for machine capacity during the fourth year would be suitable for the company under study. There are two operational requirements that the machine replacement needs to consider, that are process improvement and obsolescence. From the initial screening it was found that Option 4 was not suitable for the needs of the company as well as the market.

For the technical feasibility analysis there are two options that would meet the desired capacity and also have the flexibility for machine placement. One option involves purchasing a new machinery where as the other is to upgrade the existing machinery. Both machine options would require about 120 workers which is a reduction from 270 workers. The total electricity power consumption of the new machine is nearly half of that of the upgraded machine. However the upgraded machine was the most flexible for machine placement due to its smaller size and weight.

From the financial feasibility analysis shows that keeping the existing machinery was not economical anymore. Between the two options, the new machine has a lower equivalent uniform annual cost of 178.35 comparing to 210.49 of the upgraded machine. The planned operating cost of the replacement machine was at 34.80 Baht per case from an initial cost of 44.60 Baht per case. By weighing the financial feasibility between the new machine and upgraded machine, it was found that the new machine was more suitable for the needs of the company.

The selected machinery was the new machine because although the upgraded machine had the flexibility of machine placement, this was only a small advantage compared to other advantages that the new machine has to offer. This includes factors such as lower costs, longer maintenance coverage, and reputable supplier. Also the new machine is more economically and technically suitable for the company needs.

Also looking at the implementation results shows that the machine chosen performed to the expected capacity, which is at nearly 230,000 cases per month during the non peak period and at 290,000 cases per month during peak period. The number of workers utilized was at 120 workers. Based on data obtained during the first three months, the new average cost was at about 35.5 Baht per case. Overall, this showed that the machine is performing as expected while keeping the actual cost near to the forecasted cost. The bottleneck in the production line process was also eliminated and as well as the double handling that occurred before.

The machine replacement process in this project consists of system requirements, system analysis and design, implementation, and post implementation audit as shown below.

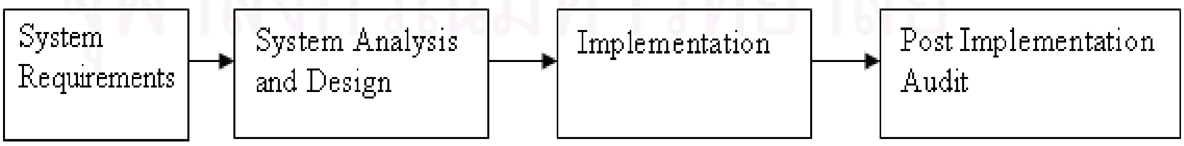

Figure 5.1 Machine Replacement in Cooking Oil Bottling Process

Based on the process shown which includes validation, selection, implementation and post implementation audit, the selected machinery was the right choice because it helped solve the problems of the company under study. The problems were solved by having higher production capacity, reducing double handling and bottleneck, and reducing the cost of producing the bottles. The objectives of the research is also met because the process above shows the planning and implementation of the replacement of the bottle making machine in a cooking oil bottling company in order to increase its production capacity.

In conclusion with the objectives of this research met and the machine replacement process developed, the work done can be utilized as ground work for future expansion of additional machinery for the company under study and also for new machinery for other companies as well.

5.2 Discussion

There are several things that went well with this project, firstly the feasibility analysis that was done. The feasibility analysis covered the 3 necessary aspects of the project that are market, technical and financial feasibility. By comparing the actual results after the implementation of the machinery, shows that the selected machinery was the correct selection and performed as expected. Also the implementation and outcome of the implementation went well despite several problems as several solutions were implemented to solve those problems. The outcome of the process was satisfactory as it can serve as a guideline for future work. However there are some drawbacks to the project, one of them are the problems that occurred with the implementation. Even with the solutions implemented there was a delay with the project. The solutions could have been implemented sooner or more solutions should be in place. Also more areas of feasibility could have been covered to give further details about the feasibility of the machinery. However the analysis that was done was a good one because it proved that for the company under study the most appropriate machine was selected based on that analysis. Also despite that there were some differences between the actual and theoretical results the similarities between them showed that the analysis was properly done. Hence the lessons learned from the project are to have better implementation solutions and also to have more areas of feasibility analysis.

Looking at the justification results and the actual results shows similarities between them. The new machinery achieved the expected capacity of the justification results which is about 240,000 cases per month and lowered production cost by 20%. The number of labour utilized was at 120 workers which is the same as the results of the study. Overall, the study went well with this continuing trend for the company.

5.3 Recommendations

The recommendation is divided into 2 parts that are scope of next phase and expansion to other product range.

5.3.1 Scope of Next Phase

Currently, other bottle sizes such as the ¼, ½, 1.5 and 2 litre bottles are being manufactured by other machinery. However in the future, the company under study can use this work as a guideline for machine replacement of other bottle sizes.

5.3.2 Expansion to Other Business Product Range

The machine replacement process can also be utilized for expansion into other business product range such as the manufacturing bottled water and soda drinks among others. This may not involve replacing existing machinery but can also be applied for new business start up's looking to invest in Thailand and purchasing new machinery.

5.3.3 Recommendation for Next Phase

Hence the recommendation for the next phase for the company under study is to start researching on additional capacity within 3 years time and to utilize the machine replacement process as a guideline to increase capacity as well as to help with the implementation process.

References

ASB. http://www.nisseiasb.co.jp/index_e.html. Nissei ASB Machine Co., : Ltd. Nissei Machine Company Limited, 2007.

Attaprecha T. Pre-feasbility Study of the Northern Refined Products Pipeline Project. Meng Chulalongkorn University, 1999.

Baum W.C., & Stokes M.T. Investing in Development: Lesson of World Bank Experience. New York: Oxford University Press, 1985.

BOI. http://www.boi.go.th/english/. BOI : Board of Investment Thailand, 2007.

Chantana C. & Sirichan T. Feasibility Study of Business and Industrial Projects. 6th edition. Bangkok: Chulalongkorn University Publishing Company, 1997.

Cooper R. & Haltiwanger J. The American Economic Review. The Aggregate Implications of Machine Replacement: Theory and Evidence. June, 1993 : 360-382.

Dauber N. A., Siegel J.G., & Shim J.K. The Vest-Pocket CPA. New Jersey: Prentice Hall, 1988.

Ebottles. http://www.ebottles.com/resins.asp Ebottles, 2007.

Gottfried S., Sepulvada J.A., & Souder W.E. Schaum's Outline of Engineering Economics. New Jersey: McGraw Hill, 1984.

Morakot Industries Public Company Limited. Management Plan 2006. Bangkok: Morakot Industries, 2006.

Nielsen Company. Cooking Oil Nov/Dec 2006. Bangkok: Morakot Industries, 2007.

Rukachantarakul K. A Feasibility Study of Investing Bunker Oil Equipment for Oil Company's Customers. MEng Chulalongkorn University, 1998.

SIPA Company. Morakot Industries Public Company Limited: Maintenance Contract. Bangkok: Morakot Industries, 2004.

Sullivan W.G., Wicks E.M., & Luxhoj J.T. Engineering Economy. 13th edition. New Jersey:

Pearson Educational International, 2006.

Voster M. http://constructionequipment.com/article/CA624074.html?industryid=23397 A Machine-Replacement Strategy, 2005.

Wikipedia (1). http://en.wikipedia.org/wiki/Blow_molding Blow Molding, 2008.

Wikipedia (2). http://en.wikipedia.org/wiki/Linear_regression Linear Regression, 2008.

WMG. Project Planning Management & Control. Bangkok: Chulalongkorn University, 2007.

BIOGRAPHY

Kevin Teoh was born on September 26th, 1982 in Malaysia. He graduated from the University of Nottingham with a Bachelor's degree in Electrical and Electronic Engineering in January, 2005. Later on, with the aspiration to acquire managerial skills in the field of engineering, he furthered his graduate study as a full time student in the program of Master of Engineering Management jointly offered by Chulalongkorn University and University of Warwick at the Regional Centre for Manufacturing Systems Engineering, Faculty of Engineering, Chulalongkorn University, Thailand from October, 2006 to March, 2008.