# CHAPTER I

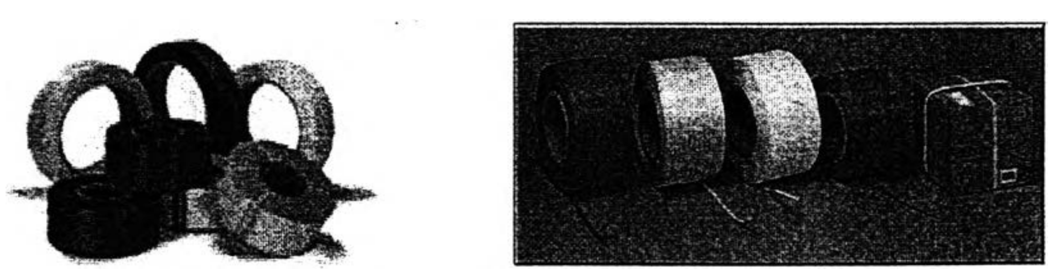
# INTRODUCTION

## 1.1 Background of the Study

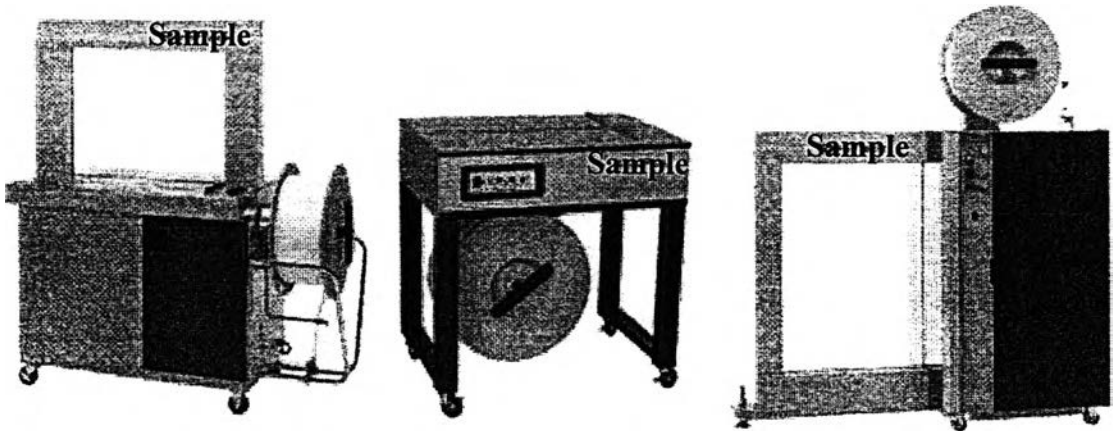
Among high competition in today business, it is essential for firms to obtain competitiveness in order to earn reasonable return and survive in the market. For manufacturing firms, repetitive failures cost them millions of baht in redesign costs, liabilities, and transaction costs. The most serious cost of these failures is the lost business that may results from customer dissatisfaction of the price or quality of the company's product. Therefore, these failures should be identified, prevented, or cured.

### 1.1.1 The Case Company

This study involves a case company who produces PP (Polypropylene) bands or PP strap used for strapping machines. Samples of PP bands and strapping machines that the company utilizes are shown in figure 1.1 below.



Sample of PP bands




Automatic Strapping Machine | Semi-Auto Strapping Machine | Automatic Strapping Machine (Heavy Type)

**Figure 1.1: Samples of PP Bands and Strapping Machines**

PP bands that the company produces can be divided into 4 categories depending on type of strapping machine. They are as follows:

1) **B (Recycle) Grade**: used for handy strapping machine.
   - Bandwidth 12 mm. in 1800 and 3000m.
   - Bandwidth 15.5 mm. in 1800 and 3000m.

2) **A Grade**: used for semi-automatic strapping machine.
   - Bandwidth 5 and 6 mm. in 4000m.
   - Bandwidth 9 mm. in 2800 and 3500m.
   - Bandwidth 12 mm. in 1800, 2000, 2500 and 3000m.
   - Bandwidth 15.5 mm. in 1600, 1800, 2000 and 2500m.
   - Bandwidth 19 mm. in 2000m.

3) **Auto (Automatic) Grade**: used for automatic strapping machine.
   - Bandwidth 9 mm. in 2800 and 3500m.
   - Bandwidth 12 mm. in 1800, 2000, 2500 and 3000m.
   - Bandwidth 15.5 mm. in 1600, 1800, 2000 and 2500m.
   - Bandwidth 19 mm. in 2000m.

4) **Heavy Grade:** used for heavy duties that needs high tensile strength and low percentage of elongation such as refrigerators strapping.
   - Bandwidth 12 mm. in 1800, 2000, 2500 and 3000m.
   - Bandwidth 15.5 mm. in 1600, 1800, 2000 and 2500m
   - Bandwidth 19 mm. in 1500m.

Every grade of PP bands can be manufactured in many ranges of colors such as Clear, White, Red, Yellow, Green, Blue, Grey, Black, Orange, Violet, Pink and Brown depending on customer specifications.

### 1.1.2 Manufacturing Process of PP Bands

The case company manufactures PP bands in batches where the production runs on the same type of product based on customer demand. In batch production, general-purpose equipment and methods are commonly used to produce small quantities of PP bands that will be made and sold for a limited time only. The specifications of PP bands are rigid. Since the company has many ranges of PP-band products, the company needs to set up the machine every time when the specification of PP bands changes such as a change in grade, size or color. The average demand for overall type of PP bands is roughly 5,000 rolls per month.

The process of producing PP bands in the case company can be depicted by figure 1.2 below:

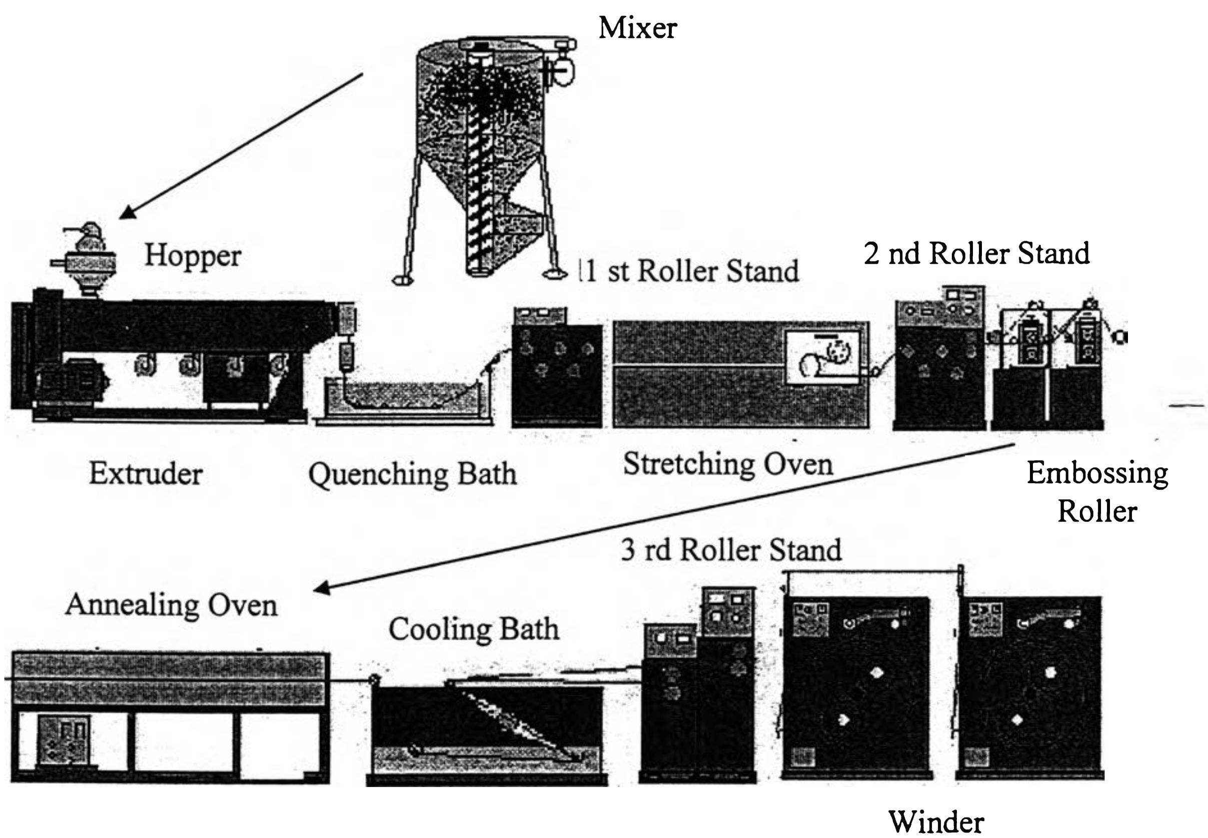



**Figure 1.2: PP-band Process**

The process of producing PP bands for the case company is explained in detail as follows:

1) Mixing PP, Calcium and Color Master Batch in the Mixer.
2) Hopper sucks the mixed materials out from the Mixer to Extruder.
3) Extruder melts the mixed materials and extrudes them through nozzle into Quenching Bath which is used for band setting.
4) 1st Roller Stand pulls PP bands from Quenching Bath, applying suitable speed for controlling bandwidth.
5) Stretching Oven stretches PP bands using different speed of two rollers in the Stretching Oven.

6) $2^{nd}$ Roller Stand pulls PP bands from Stretching Oven.
7) Embossing Rollers embosses on two sides of PP bands (as shown in figure 1.3) in order to eliminate the tendency to split along the length of PP bands and also make more friction on band for feeding in strapping machines.

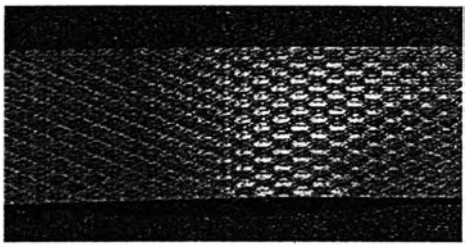


**Figure 1.3: Embossment on PP Bands**

8) Annealing Oven adjusted PP-band curve which cause from embossing process.
9) Cooling Bath cools down PP bands before winding.
10) $3^{rd}$ Roller Stand pulls PP bands from Cooling Bath.
11) Winding rollers at Winder wind PP bands roll by roll depending on product specification.

### 1.1.3 Problems of PP-band Production

There is the critical failure of breakage in the manufacturing process of PP bands. The major yield loss contribution for the line process is at the stretching process in the stretching oven where there are high rate of PP-band breakage as figure 1.4 shown below. This process is the most important in the line process of producing PP bands because it is the most vulnerable point of breakage.

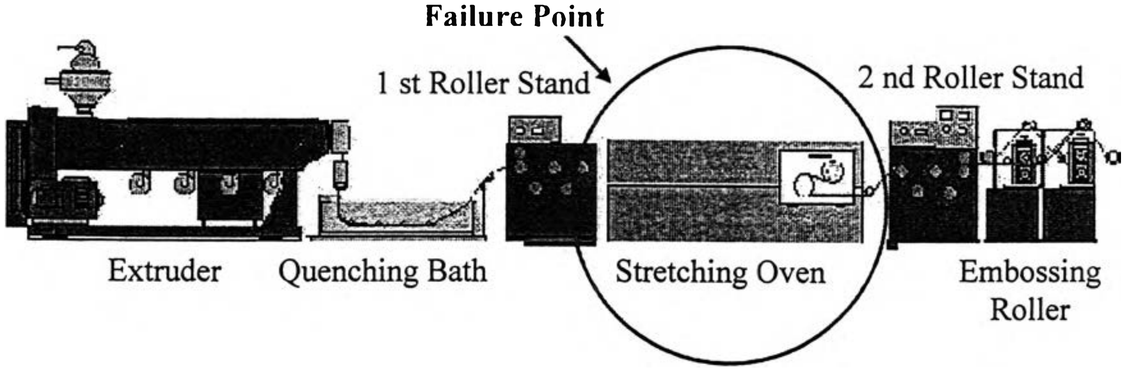



**Figure 1.4: PP-band Breakage at Stretching Oven**

The breakage point happens between these two rollers which rotate at different speeds in the stretching process as shown in figure 1.5.

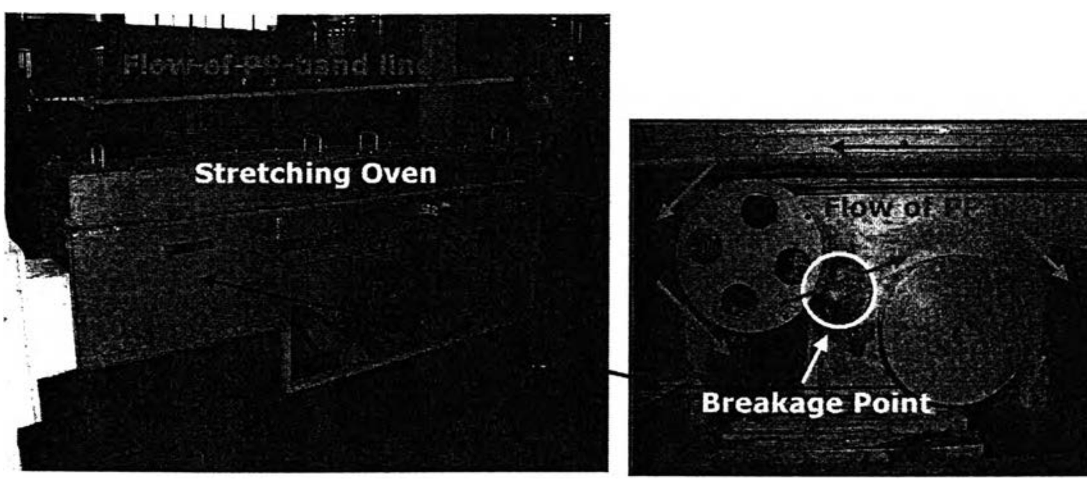



**Figure 1.5: Breakage Point**

There are three main costs associated with the breakage failure in the manufacturing process of PP bands as followings:

- Material cost: In the last 8 months from January 2004 to August 2004, the case company has suffered total loss more than 5.7 tons of material, mostly Polypropylene. This includes loss in normal processes like a loss from change in grades, sizes or colors. Table 1.1 shows that the breakage failure of PP bands is over 3.6 tons of material which are more than 60 % of total production loss.

**Table 1.1: Data of Total Product Loss Compared with Breakage Failure Loss from the Study PP-band Line from January 2004 to August 2004**

| Month | Material loss (kg.) | | | | Total Material Loss (Kg.) | Percent of loss from breakage failure |
|---|---|---|---|---|---|---|
| | Normal setup | Change of specification | Electricity breakdown | Breakage Failure | | |
| Jan | 149.32 | 74.09 | 2.9 | 706.67 | 932.98 | 75.74% |
| Feb | 86.39 | 49.85 | - | 393.95 | 530.19 | 74.30% |
| Mar | 195.85 | 93.29 | - | 610.54 | 899.68 | 67.86% |
| Apr | 242.59 | 40.3 | 4.23 | 377.83 | 664.95 | 56.82% |
| May | 298.64 | 31.94 | 22.75 | 300.24 | 653.57 | 45.94% |
| Jun | 93.49 | 55.1 | - | 286.22 | 434.81 | 65.83% |
| Jul | 362.05 | 47.04 | 27.79 | 654.04 | 1,090.92 | 59.95% |
| Aug | 220.8 | 27.02 | - | 271.28 | 519.1 | 52.26% |
| **Total** | **1,649.13** | **418.63** | **57.67** | **3,600.77** | **5,726.2** | **62.88%** |

Loss from normal setup and change of specification are the loss from normal operation and they are uncontrollable. Loss of electricity breakdown is also uncontrollable because it occurred from the abnormal situation. Breakage failure loss is the loss from unknown cause(s) and it is perceived as controllable loss. The table above shows that losses of material in the process are mostly from breakage which accounts for 62.88% of the total material loss in the process. Thus, the case company aimed to reduce the loss from breakage.

- Labour cost: It is the labour cost wasted in unproductive process of fixing the machine after the breakage to make the production process normal.

- Opportunity cost: This cost includes the recovery time and may include the cost of loss of opportunity to sell the products.

The loss of productivity from material cost and labour cost from the breakage failure increases the product cost as a result of higher overhead, leading to company's competitive disadvantage. Now the case company still keeps the same product price in order to be able to sell the PP bands in the market even though the margin is relatively lower than its competitors. However, if the contribution profit from PP bands cannot cover the other costs of the company, the company needs to raise its product price, which will make its product harder to sell. The company may lose an opportunity to sell because customers can buy goods from other company if they consider the quality of product is the same. It is necessary for the case company to find ways to reduce the overhead from the breakage in stretching process.

Consequently, the case company wants to investigate failure found in PP-band line by applying **Failure Mode and Effects Analysis (FMEA)** technique which the company believes that this technique will identify and eliminate potential causes of failures that may arise. FMEA allows for the elimination of costly failures in the manufacture of PP bands by ensuring that critical issues are addressed before expensive commitments have been made.

## 1.2 Statement of Problem

For consumer products in Thailand market, the rivalry is relatively high and normally is based on the price of the products. The case company has manufactured PP bands which are considered as consumer products for industrial customers. In the market, each company producing PP bands tries to reduce its product cost in order to compete on price because PP bands are price sensitive product and customers prefer to buy product from anywhere that can give them the lowest price. Therefore, firms who can keep their manufacturing cost lower than competitors can enjoy the high profit and be able to reduce its set price when competing with its rivalries. On contrary, firms with high manufacturing cost are at the risk of losing business if there are fierce price competitions in the market.

The case company has suffered the high manufacturing cost, mainly due to higher overhead from loss of material and labour productivity. Material and labour productivity are lost from the breakage in the production process because every time breakage happens the machine will stop functioning and operators have to set up the machine. Material in every process line will be lost due to this breakage. This critical failure of breakage occurred at the stretching process in the stretching oven where there are high rate of PP-band breakage. This process is the most important in the line process of producing PP bands because it is the most sensitive point of breakage. There is no sign of recovery since the breakage has not been reduced and controlled as the time passed (see table 1.1). In other words, the case company lacks the ability to lower its product cost occurred from the breakage of PP bands in the normal production process. The real causes of this breakage at stretching process are unknown and obscure.

Since the production goal of the company is to produce PP bands at the low cost relative to that of competitors with features that are acceptable to customers, therefore the company aims to find way to solve breakage failure, improve its productivity and prevent the failure in the production process. This will reduce the manufacturing overhead, leading to reduced manufacturing cost of PP bands and ultimately raise the company's competitive position in the industrial market.

## 1.3 Research Objective

The objective of this research is to eliminate or reduce breakage problem in the PP-band line of the case company by using FMEA technique.

## 1.4 Research Scope

This study will concentrate exclusively on the breakage problem of PP bands in the stretching process of the PP-band line, as shown in figure 1.6.

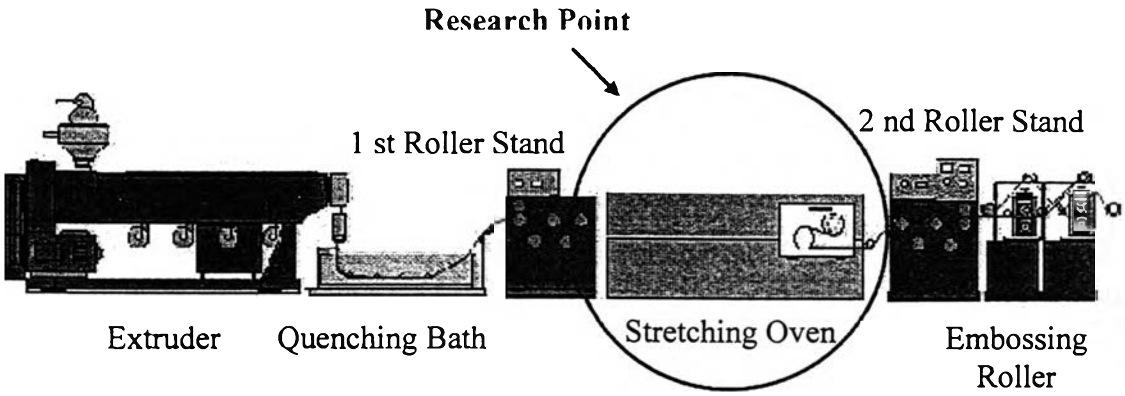



**Figure 1.6: Research Point in the Line Process**

## 1.5 Expected Results

The expected results of this research are as follow:

- To know the real causes of PP-band breakage problem
- To find the solution so as to reduce or eliminate the breakage problem.

## 1.6 Expected Benefits

The benefits expected from this research are as follows:

- PP-band breakage can be dramatically reduced, which will save production cost.
- Increased machine productivity.
- Reduced machine maintenance time
- Meeting production target schedules
- The research can be a case study for others researchers or others companies who are interested in FMEA technique.
- The research can build awareness of the case company employees in using FMEA technique in others areas or sections of the organization.

## 1.7 Research Methodology

In order to conduct the research of **"An Application of FMEA Technique for Solving PP-band Production Problems"**, there are ten steps involved:

1) Review of literatures and related studies such as FMEA, design of experiment, and statistical principles.
2) Collect data of existing problems from yield reports and data from production operators and define the FMEA boundaries.
3) Set up a FMEA team consisting of members from process engineering, maintenance team, and production operators & technicians.
4) Brainstorm among team members to identify possible causes and effects of PP-band breakage by applying a Cause-and-Effect (Fishbone) diagram, and FMEA (Failure Mode and Effect Analysis) for in dept technical issues.
5) Design of Experiment (DOE) to determine the effect of significant factors (obtained in step 4) on the breakage failure and to determine the combination of factors that will reduce the breakage failure.
6) List down potential solutions and assign the responsibility for corrective action to each team members.
7) Review improvement of PP-band breakage rate after the implementation of each corrective action and identify further corrective action until the breakage rate reduces to an acceptable level.
8) Monitor for other unforeseen impacts on the process.
9) Summarize the findings and recommend the solution.
10) Prepare thesis report and final examination.

## 1.8 Research Schedule

This research is scheduled as shown in the detail in the following table.

**Table 1.2: Research Schedule**

| No | Activities | October | | | | November | | | | December | | | | January | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Review of literatures and related studies | ■ | ■ | ■ | ■ | | | | | | | | | | | | |
| 2 | Data collection of PP-band failure and define FMEA boundaries | | | | | ■ | ■ | ■ | ■ | | | | | | | | |
| 3 | Set up a FMEA team | | | | | | | ■ | ■ | | | | | | | | |
| 4 | Brainstorm with team members to identify possible causes and effects | | | | | | | | | ■ | ■ | | | | | | |
| 5 | Design of Experiment | | | | | | | | | | | ■ | ■ | ■ | ■ | | |
| **No** | **Activities** | **January** | | | | **February** | | | | **March** | | | | **April** | | | |
| 6 | List down potential solutions and assigns action to team members | | | ■ | ■ | | | | | | | | | | | | |
| 7 | Review improvement of PP-band breakage rate | | | | | ■ | ■ | ■ | ■ | | | | | | | | |
| 8 | Monitor for unforeseen impacts | | | | | | | | | ■ | ■ | | | | | | |
| 9 | Summarize the findings and recommend the solution | | | | | | | | | | | ■ | ■ | ■ | ■ | | |
| 10 | Thesis write up and submission | | | | | | | | | | | | | ■ | ■ | ■ | ■ |