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# Increasing Efficiency of Production Line in Plastic Water Bottles Production: A Case Study

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**Abstract**

This research aims to improve the production line efficiency in plastic water bottles line by using four techniques: 1) Work study 2) Process analysis 3) Timing and 4) Line balancing. A study conducted by collecting data from a document of the plant and related research. The time of work employees in production by plastic water bottles and analysis process to find the problem and the increase of the production efficiency. The data were evaluated to compare before and after the process. A study found that current production line with four departments and the problem in production bottleneck at the third department which screen of plastic water bottles takes a lot of time-- about 10.40 minutes. The one department (3rd) has the job of producing the 5 tasks in the production line was 40.39 percents. The researcher studied standard time to work and find solutions of balance in production. In the first technique to incorporate the idea of the third department was reduced to only 3 departments to improve production line efficiency for the new system by more than 40 percents.


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*Keywords:* Efficiency, line balancing, process analysis, timing

## 1. Introduction

Packaging is necessary to produce a discharge to facilitate the transportation of the stability and protection. Packaging can be produced from various raw materials such as paper, glass and plastic. At present, it can't be denied that the most common containers on the market are made of plastic too. That is the most plastic bags can be purchased at a time. This may have been in the shop several times each. Packaged Drinking water in order to attract and shapes are interesting in buying a drink. Therefore, this industry is vital to every industry rely on packaging. Data from the survey found that the primary plastic packaging plastic around 1,000 guests in 2012 by 87 percent of households in the lower eastern Bangkok [1]. There are approximately 100,000 workers in the industry. Manufacturing process is Film Process, Injection Molding, Blow Molding and Thermoforming plastic industry etc. In Thailand, there are 4,560 factories registered with the plant. [2] There are 183,703 workers and an investment is more than 136,795 million baht. Plastics industry, the industry is producing polymers derived

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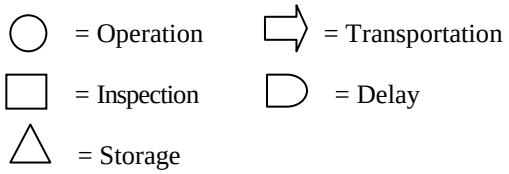
from the petrochemical industry. Industry is to convert plastic into useful products in industry groups Thailand's plastic industry classification systems, such as multi-use based on Thailand Standard Industrial Classification or TSIC or International Standard Industrial Classification or ISIC etc. Plastic container operators such as plastic bottles and plastic jars, both locally and abroad increased. In particular, China is reputed as Chinese products which are much cheaper because of the huge Chinese market. It can be produced in large quantities and low cost per piece. Thus, the overall picture of the industry is possible. The organization in this industry is to accelerate the development of their owner to survive by improving product quality and services to satisfy the customers. This research is to optimize the production processes in manufacturing plastic water bottles, case studies, applications of techniques of Industrial Engineering 4 : Work Study, Process Analysis, Direct Time Study, and Line Balancing in order to reduce the imbalance in the production process and the bottleneck in the process. Suggestion is that there is a possibility to optimize the manufacturing scale up and as a guide to improve the other related to production. Pongsakorn [3] states that the ceramic factory production optimization study is the fourth process of casting anchor site. The casting Ondo Soap Disco's video for casting Brown and molded with Rollers. The technique used to reduce the loss of movement of the wheelchair to move within the plastic water bottle, this makes it possible to reduce the amount of movement and the procedures that are necessary.

## 2. Methodology

*2.1 Work study includes motion study and time study which can be defined as a study of method and work evaluation that focuses on human resources and environmental resources. Method study and work measurement using for human work and other factors effected to work efficiency [4,5] Work operation analysis technique to reduce unnecessary work and find the best and the fastest work including improve the work standard and planning management using reinforcement [6]*

*2.2 Production process analysis process chart can be used to record data appropriately to make it comfortable to read. It's symbol. It starts by objects move to production line and record data. Chart analysis uses 5 symbols; there are [6]*




*2.3 Direct Timing [7]*

$$n = \left[ \frac{\frac{k}{s}\sqrt{n\left(\sum x_i^2\right) - \left(\sum x_i\right)^2}}{\sum x_i} \right]^2$$

When $n$ is amount of time,
$s$ is accuracy,
$k$ is components o reliability.

Table 1. Reliability [7]

| Reliability | k |
|---|---|
| 68.3 | 1 |
| 95.5 | 2 |
| 9.7 | 3 |

*2.4 Production balance [8,9]*

2.4.1 Production balance strategic efficiently
2.4.2 Measurement and work analysis
2.4.3 Assign and divide sub-work
2.4.4 Assign the relation of before and after of sub-work
2.4.5 Analysis Job
2.4.6 Manage new work load
2.4.7 Improve sub-work

## 3. Results and Discussion

Case study factory has studied a 820 ml-sizes plastic bottle on blowing plastic bottle as shown in figure 1.

Fig. 1. A 820ml-sizes water plastic bottle

*3.1 A study and collecting data*

Researchers collected data and related methodology and plastic bottle production process as;

3.1.1 Colors and polymers
3.1.2 Blowing plastic bottle process
3.1.3 Screening plastic bottle
3.1.4 Packaging production process

*3.2 Study production factor before improvement*

Timing of each sub-work with accuracy was $\pm$5% and reliability 95.5 %. The mixing process and polymers, plastic bottle blowing process, the plastic bottle screen and the plastic water bottles and packs are outlined below.

Table 2. Shows the timing function of each sub-task. The colors and polymers

| Sub task | Time 1 | 2 | 3 | 4 | 5 | Average time (s) | description |
|---|---|---|---|---|---|---|---|
| 1 | 72.23 | 69.41 | 68.13 | 70.55 | 67.22 | 69.50 | The polymers are mixed. |
| 2 | 45.05 | 43.56 | 45.12 | 46.08 | 42.34 | 44.43 | Color is weighted and mixed. |
| 3 | 132.24 | 130.13 | 133.34 | 132.21 | 130.18 | 131.62 | Turn on switch to mix. |
| 4 | 14.10 | 15.03 | 19.15 | 15.26 | 20.14 | 16.73 | Take out polymers |
| 5 | 16.14 | 15.50 | 17.33 | 16.04 | 15.29 | 16.06 | Blowing |

$$n = \left[ \frac{\frac{k}{s}\sqrt{n\left(\sum x_i^2\right) - \left(\sum x_i\right)^2}}{\sum x_i} \right]^2 = \left[ \frac{\frac{2}{0.05}\sqrt{\left(5(86595.41) - (658.1)^2\right)}}{658.1} \right]^2 = 0.435 \text{ time}$$

Calculate the number of times the timer is 2.073, which is less than the number of times. The timer has to show that it is five times the amount of time spent on the timing enough. No need to add a timer.

Table 3. Timing of each sub task, screening machine

| Sub task | amount 1 | 2 | 3 | 4 | 5 | Average (s) | description |
|---|---|---|---|---|---|---|---|
| 1 | 290.41 | 301.55 | 304.32 | 300.57 | 307.03 | 280.77 | Check screening block |
| 2 | 300.43 | 303.31 | 301.51 | 308.15 | 305.20 | 303.70 | Take screening block to screen machine |
| 3 | 54.56 | 58.43 | 60.06 | 57.21 | 56.44 | 57.30 | Take color into block |
| 4 | 10.55 | 11.34 | 10.23 | 12.45 | 11.11 | 11.13 | Operate the machine |
| 5 | 7.05 | 7.12 | 7.21 | 7.04 | 7.11 | 7.10 | Take bottle to screen |

$$n = \left[ \frac{\frac{k}{s}\sqrt{n\left(\sum x_i^2\right) - \left(\sum x_i\right)^2}}{\sum x_i} \right]^2 = \left[ \frac{\frac{2}{0.05}\sqrt{(5(449840.50) - (1498.94)^2)}}{1498.94} \right]^2 = 1.69 \text{ time}$$

Table 4. In each sub-timer function, Pack a plastic water bottle

| Sub task | amount 1 | 2 | 3 | 4 | 5 | Average (s) | description |
|---|---|---|---|---|---|---|---|
| 1 | 25.11 | 23.55 | 24.43 | 22.56 | 23.32 | 23.79 | Staff prepares plastic bag to pack bottles |
| 2 | 262.80 | 262.50 | 264.40 | 264.10 | 262.20 | 263.20 | Staffs pack bottles. |
| 3 | 30.41 | 32.21 | 31.58 | 34.03 | 35.12 | 32.67 | Staffs keep bottles. |

$$n = \left[ \frac{\frac{k}{s}\sqrt{n\left(\sum x_i^2\right) - \left(\sum x_i\right)^2}}{\sum x_i} \right]^2 = \left[ \frac{\frac{2}{0.05}\sqrt{(5(346375.1) - (1316)^2)}}{1316} \right]^2 = 0.017 \text{ time}$$

To calculate the number of times the timer is 0.017, which is less than the number of times the timer has shown that it is five times, the amount of time spent on the timing enough to make a timer.

*3.3 The problem with the sample plant*

3.3.1 Collect information, the time it takes to produce the first production cycle (Cycle Time) (the production is processed one hour and 30 minutes with plastic 25 kg yellow 25 g blue 4 grams put into production will be counted as one production cycle.

3.3.2 Targeting to optimize the production line. In the production of plastic bottles of water, at least 10 percent in the first round of the manufacturing process, the current study found that there is an imbalance in the production system, the bottleneck in the screening process as shown in Table 5.

Table 5. Time table of each station

| Station | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Time/ minute | 5.04 | 3.16 | 10.4 | 5.33 |
| Performance (station)% | 42.29 | 32.19 | 41.11 | 40.48 |
| Performance (total)% | | | 59.58 | |
| Production time (total)/m | | | 23.93 | |

Note: station 1 is color and polymer mixing
2 is plastic bottle blowing
3 is water plastic bottle screening
4 is plastic bottle packing

3.3.3 Cycle time is the most work is the bottleneck and determine the capacity of this production line. We will use this station. The screen is a single point in the calculation is then used to calculate the single terminal station 3 just because it is the most time-consuming work. Although the station before or after this station. Must wait for the completion of this first. They will work in the next Table 6.

Table 6. Shown the time of each sub task of screening machine

| station | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Production time /minute | 4.08 | 5.05 | 0.96 | 0.19 | 0.12 |
| Performance (total)% | | | 41.11 | | |
| Total production time % | | | 10.04 | | |

Note: substation 1 is water plastic bottle checking machine
2 is block has been taken to the machine
3 is color filled into the machine
4 is screening bottle

## 4. Conclusion

Researchers have studied the production process and production lines, plastic water bottle in the process about the problem. A summary of the current state of the manufacturing process of plastic water bottles before the updated of four workstations, the study was conducted for each time step. In summary, a standard time for each work station has shown in Table 7.

Table 7. Shown the time of each station of water plastic bottle production process

| No | Station | Time (s) |
|---|---|---|
| 1 | Colour and polymer | 5.40 |
| 2 | Plastic blowing machine | 3.16 |
| 3 | Screening bottle machine | 10.20 |
| 4 | Packing plastic bottle (packaging) | 5.33 |

From the study process, the current was found to produce the fire production cycle is Cycle Time Average is 10 minutes 20 seconds, but this process is not balanced to the point of bottlenecks in the process station 3 is the screen plastic water bottles. Thus, researchers have to balance production techniques to improve the efficiency of production lines. The calculation of that required a subset of the three station to optimize the production line. The summary results firsts after the update as show in Table 8.

Table 8. Compare the improvement before and after

| No | Details | before | after | Increase/decrease |
|---|---|---|---|---|
| 1 | Amount of station | 5 | 3 | decreased 40 % |
| 2 | Operation time (minute) | 10.20 | 10.20 | same |
| 3 | Performance of line balancing % | 40.75 | 67.75 | 27.00 |

The results of this study were to optimize the production process of plastic water bottles added by research objectives of the study. To optimize the process, at least 20 percent of plastic water bottles after optimizing production lines so researchers can improve the performance by 27 percents in the near future, and design to implement new systems more than 40 percents.

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