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REDUCTION OF CYCLE TIME OF PLASTIC BOTTLE PRODUCTION USING LEAN METHODOLOGY AT CHAI HENG PLASTIC (MFG) SDN. BHD

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Abstract

This study addresses a high cycle time in the production of bottle plastic at Chai Heng Plastics (MFG) SDN. BHD. Due to the high cycle time could potentially contribute to a deterioration of customer's dissatisfaction. Other than that, company's staff will also be felt stressed by need to manage the customers' emotions and expectations while waiting, as well as by the peak seasons caused by uneven workload and scheduling practices. The process, starting from prepare raw materials of a plastics until the product arrived at customer have been analyzed. The non-added value activities were identified, and the action initiated were based on the lean concept. This study has helped the Chai Heng Plastics (MFG) SDN. BHD. staff and management to identify the weak areas in the process for improvement.

Keywords: Cycle time; Plastic bottle; Customer's dissatisfaction; Non-value added; Late arrived

1.0 INTRODUCTION

This paper is a case study explaining about the implementation of lean method in order to reduce cycle time of the plastic bottle production at Chai Heng Plastics (MFG) Sdn. Bhd.

Plastic bottle manufacturing in this company have seven machinery included which are mixer machine, plastic injection moulding, PET preform, stretch and blow moulding, hot and cold process, inspection and packaging(Belcher, 2007). The company have a *daily demand* with total of *15,000 units*.

Lean manufacturing is one of the philosophies that used worldwide in order to create a huge continuously improvement whether in services or products industries(Bhasin & Burcher, 2006). The most useful that used to visualize and identify the problems in process is Visual stream mapping (VSM).

(Liu & Yang, 2017) in the previous study state that, by analyzing current state of the process, the problem can be identified and surfaced. Furthermore, VSM have been used worldwide in every industry in order to maximize their profit and compete with other company to achievecustomer's requirement.

2.0 LITERATURE REVIEW

High density polyethylene (HDPE) is widely used in plastic industries in the world. This resin used in making many types of bottles and containers. Apart from that, it's also have characteristics that suitable such as unpigmented bottles are translucent and have a best of properties and stiffness which is very well suitable for packaging products with a short life such as dairy (Amni & Binti Roslan, 2013). Other than that, HDPE is good chemical resistance which is used for packaging of household and industrial chemicals such as detergents and bleach. Thus, the pigment of HDPE bottles is well to stress crack resistance than unpigmented HDPE.

The first stage in bottle manufacturing is plastic injection moulding. The PET is heated and placed in a mould, where it assumes the shape of a long, thintube means that the process in which the plastic isforced into the mould is called injection moulding(Widiyati & Aoyama, 2013). The tube of PET, now called a parison, is then transferred into a second, bottle-shaped mould. A thin steel rod, called a mandrel, is slid inside the parison where it fills the parison with highly pressurized air, and stretch blow moulding begins: as a result of the pressurized air, heat and pressure, the parison is blown and stretched into the mould, assuming a bottle shape(Gaspar, 2019). To ensure that the bottom of the bottle retains a consistently flat shape, a separate component of plastic is simultaneously joined to the bottle during blow moulding.

The mould must be cooled relatively quickly, so that that the newly formed component is set properly. There are several cooling methods, both direct and indirect, that can effectively cool the mould and the plastic. Water can be coursed through pipes surrounding the mould, which indirectly cools the mould and plastic. Direct methods include using pressurized air or carbon dioxide directly on the mould and plastic.

Once the bottle has cooled and set, it is ready to be removed from the mould. If a continuous moulding process has been used, the bottles will need to be separated by trimming the plastic in between them. If a non-continuous process has been used, sometimes excess plastic can seep through the mould during manufacturing and will require trimming. After removing the bottle from the mould and removing excess plastic, the bottles are ready for transportation.

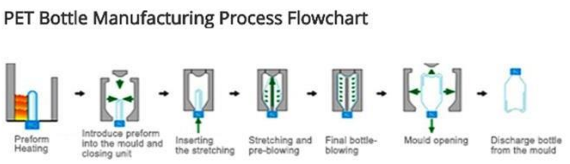

Figure 1 Process of plastic bottle manufacturing

Based on previous study, the researcher developed a FC in order to analyze the cause of the faults in organization (Cieslak & Chawla, 2009). The finding then got seven major cause categories, and each has its subcategories. In general, the goal of FC is to define the problems or causes that can occur for each operation during the production process, in order to further correct them. The figure below shows the example of FC of previous study.

PDCA is a lean manufacturing methodology which is created early of 1930 when quality management focusing on the competitiveness market all over the world (Garza-Reyes, Torres Romero, Govindan, Cherrafi, & Ramanathan, 2018). In addition, this methodology begins to be used worldwide as for quality control for products. But however, year by year, this tool started rapidly canbe used in organization level. The following shows the four stages of PDCA cycle.

Value stream mapping is also a method used to improve the process lead time by identifying the non-value-added activities that existed in each of the process(Tyagi, Choudhary, Cai, & Yang, 2015). Based on previous study, the reasons why VSM is chosen because its help to understand the current state of the process. When the current state is identified, only then the future state of improvement can be developed and implementation plan(Sundar, Balaji, & Satheesh Kumar, 2014).

3.0 PROBLEM STATEMENT

Chai Heng Plastic MFG (M) SDN BHD having a problem that the time it takes for the product to produce and send an order to a customer is perceived as too long. It is not known where in the process that most of the time is spent as well as what can be done to reduce it.

The average of previous years, 85% of customers request delivery as soon as possible. This is understandable as Chai Heng Plastic MFG (MFG) SDN BHD supplies plastic product. The customer needs could therefore potentially be catered to in a better way if the lead time was decreased. However, to be able to decrease the lead time it is important to obtain an understanding of where in the process most of the time lies.

4.0 OBJECTIVES

The objective of the study is to reduce cycle time of the plastic bottle of manufacturing at Chai Heng Plastics MFG (M) SDN BHD by:

I. Analysing current Value Stream Mapping (CVSM) to reduce the wastes and non-value-added activities.
II. Identify the location of bottleneck and reduce them.

III. Reduce high cycle time of process and implementing kaizen in process flows of Chai Heng Plastic MFG (M) SDN BHD.

4.0 RESULT AND DISCUSSION

In order to achieve the objectives of study, current state mapping has been developed to identify the bottleneck of the process flow.

Table 1 Daily output

Description	Month	July 2019						
	Days	1	2	3	4	5	6	Average
Mixer machine	Kg	244800	244775	244775	244776	244779	244800	244788
Plastic Injection Moulding	Pcs	13056	13040	13055	13054	13056	13040	13050
PET preform	Pcs	26112	26110	26111	26112	26110	26112	26111
Stretch and Blow Moulding	Pcs	13056	13050	13050	13053	13056	13055	13053
Hot and cold process	pcs	19584	19570	19572	19575	19577	19584	19577
Inspection	Pcs	4080	4075	4076	4078	4078	4080	4078
Packaging	Pcs	9792	9790	9791	9791	9791	9792	9791
Average		14280	14272	14276	14277	11912	14277	

Table 2 Hourly output

Description	Month	July 2019						
	Days	1	2	3	4	5	6	Average
Mixer machine	Kg	1920	1919	1919	1920	1920	1920	11518
Plastic Injection Moulding	Pcs	36000	36000	36000	35999	35998	35998	215995
PET preform	Pcs	3840	3840	3838	3840	3839	3835	23032
Stretch and Blow Moulding	Pcs	1920	1920	1920	1921	1921	1920	11522
Hot and cold process	pcs	2880	2881	2880	2879	2880	2880	17280
Inspection	Pcs	600	600	601	600	600	600	3601
Packaging	Pcs	1440	1440	1440	1440	1440	1440	8640
Average		48600	48600	48598	48599	48598	48593	

Total average production output for six days of July 2019 was at a volume of 326,097 units of plastic bottles. The average production achieved for six days of July 2019 was at 83.33%. CHP looked up to the production daily report including 8.5% rejects. In CHP, there are 8 hours working exclude half an hour for six days in a week. Moreover, there is 0.5 hours unpaid lunch break in the middle of workday. Takt time of the process was taken which for available minutes for production over required units of product as shown below.

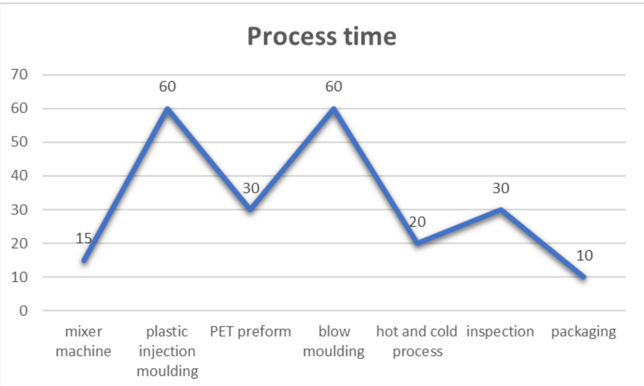

Figure 2 Current process time

$$Takt\ Time = \frac{Available\ minutes\ for\ production}{Required\ units\ of\ production}$$

$$Takt\ time = \frac{28{,}800}{15{,}000}$$

$$Takt\ time = 1.92\ secs$$

Both cycle time of plastic injection moulding and stretch and blow moulding need to be below 51 seconds so that it does not exceed the takt time of the process as shown in figure 3.

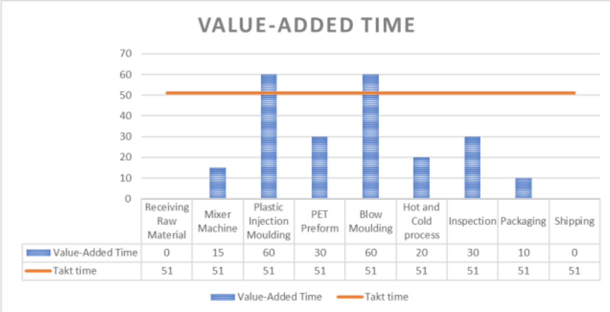

Figure 3 Value-added time

Figure 21 shows process vs value-added time of bar chart diagram. As stated in the bar chart, there are having two highest value-added time for whole process which are plastic injection moulding and stretch and blow moulding process. The actual time for both processes is 60 seconds for every 32 pieces of product out from machine as per record by operator. In other word, the takt time for a piece of product out is 1.92 seconds. But, if the efficiency of machine totally 100%, so the takt time turn to 1.875 seconds which is below the real takt time of 1.92 seconds. Unfortunately, the machine cannot be 100% working perfect. So, the takt time of a product out with machine efficiency of 85% so the value is 2.205 seconds which is exceeding the real takt time of 1.92 seconds. (Birkby, 2014)

Table 3 Takt time before improvement

Process	Takt time with machine efficiency (seconds)	
	100%	85%
Mixer Machine	0.025	0.03
Plastic Injection Moulding	1.875	2.21
PET preform	0.937	1.10
Stretch and Blow Moulding	1.875	2.21
Hot and cold process	0.312	0.37
Inspection	1.5	1.76
Packaging	0.416	0.49

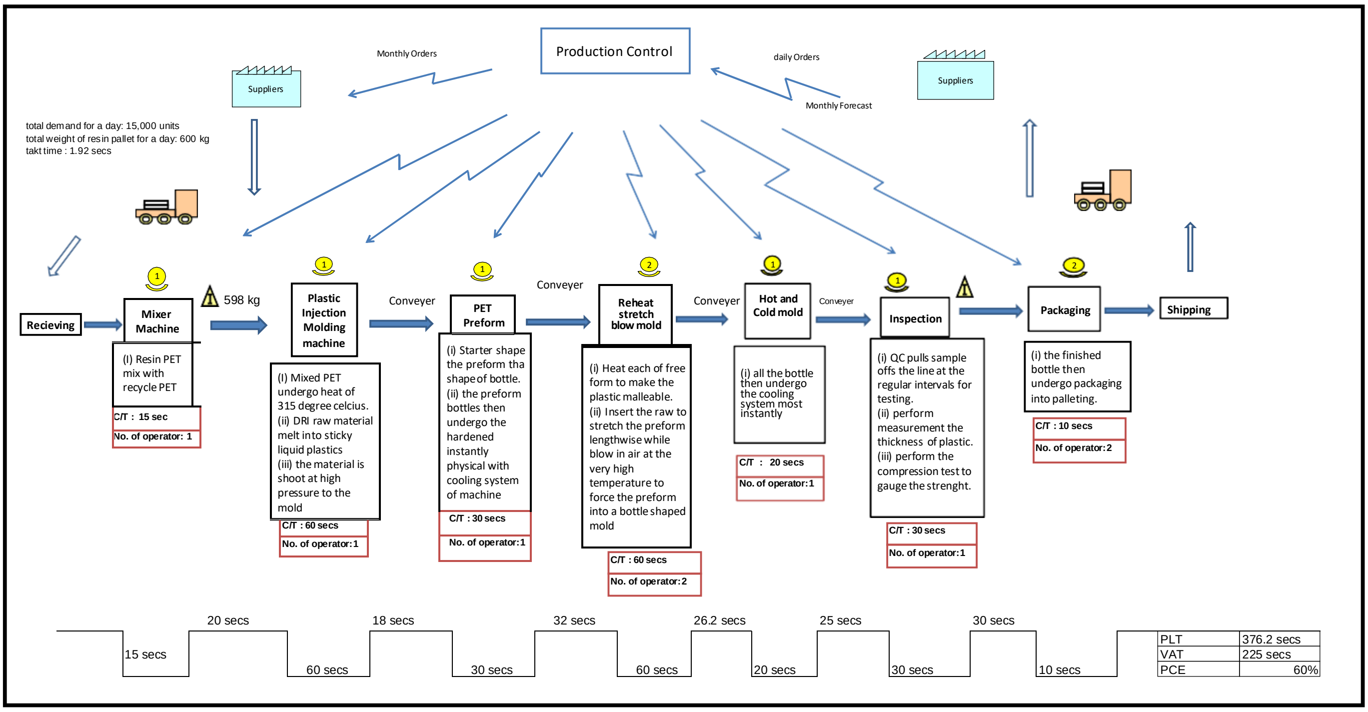

Figure 4 Current State Mapping

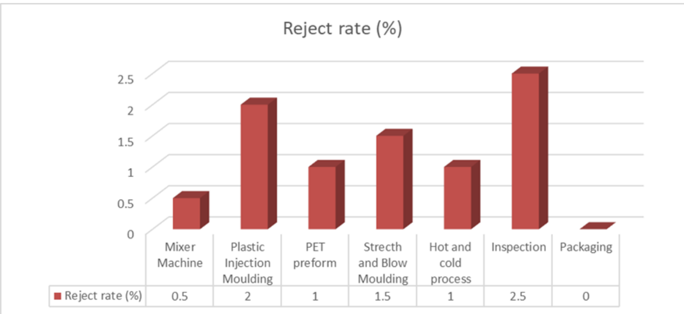

Figure 5 Reject rate

There overall reject rate for each of the process is 8.5% which are 1,275 pieces of products are rejected. The rejected products may be reparable or irreparable due to the output does not correspond in quality specification, standard, and other technical norms.

These rejects occur possibly cause of the result of incorrect adjustment of a machinery tools, malfunctioning of equipment's, errors in technical specifications such as draft or plans, disruption of procedure discipline, or the operator's low-level skill.

Production rejects are reduced by top management and technical measures, involving the mechanization and automation of production processes, proper maintenance of equipment and fitting and implementation of the preventive maintenance for the methods of technical control.

From the bar chart also clearly shows that, every stage has defects occurs. Mostly high number of defects is plastic injection moulding process of 2%.

5.0 FUTURE CALCULATION DATA

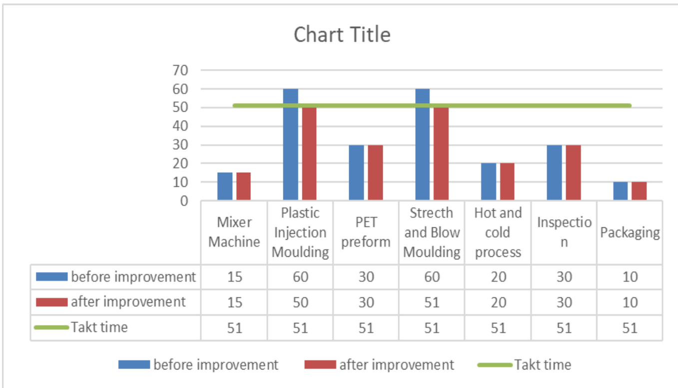

Figure 6 Data before and after improvement

Based on the graph, the process time for both plastic injection moulding and stretch and blow moulding is slightly fell from 60 seconds to 50 seconds and 51 seconds. For plastic injection moulding, before improvement with machine efficiency of 85%, the actual takt time is 2.205 seconds. But, after improvement, the takt time is 1.83 seconds which is below the real takt time of 1.92 seconds. As for stretch and blow moulding process, with machine efficiency of 85%, the takt time is 2.205 seconds but after improvement, the takt time is fall to 1.87 seconds which is also belowthe real takt time of 1.92 seconds.

However, theoretically, by create a kaizen at the plastic injection moulding process will also create a kaizen for other process.

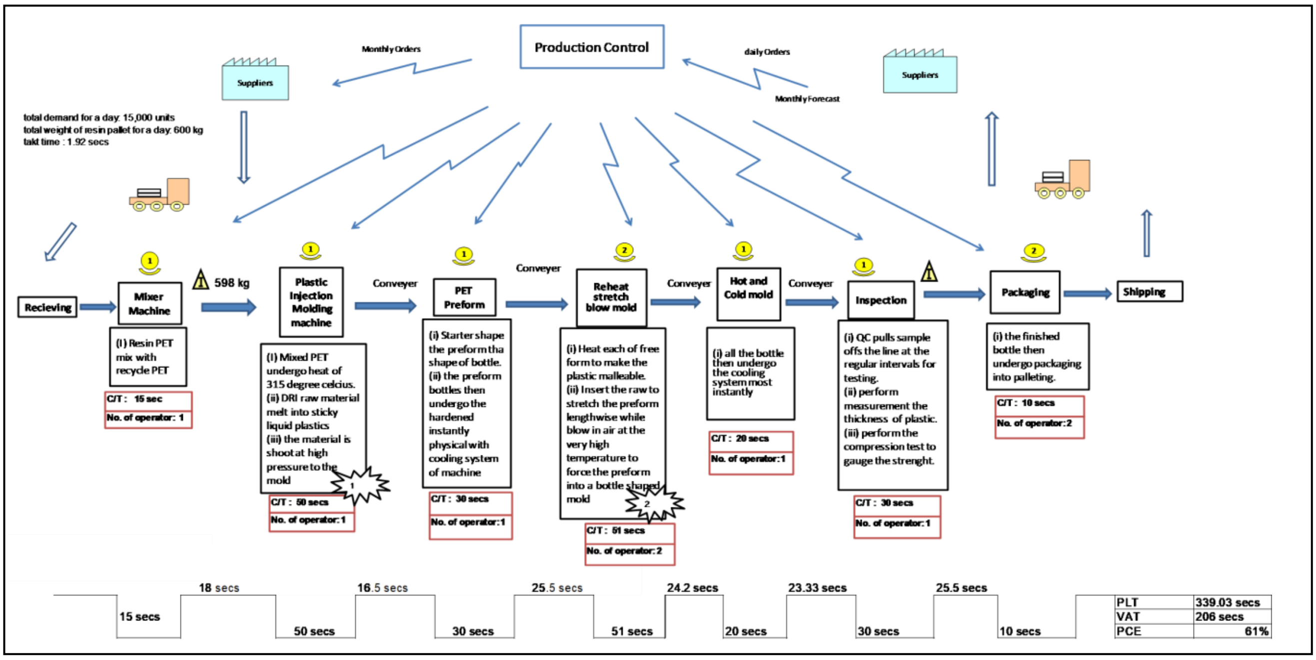

Figure 7 Future state mapping

6.0 PROCESS IMPROVEMENT

There are several actions have been taken after all the causes of the problems that contribute to the late delivery of the products have been recognized. Improvements were made based on the kaizen burst through the current state mapping of VSM.

a) Provide training

The operators at production department are lacking training and insufficient of hands-on and practical experience. At CHP company, most of operators does not have enough training because the operators are hired not based on their work experiences and education. When the current operators attend enough training and have competency certificate, there are many benefits that company will gain. The benefits that having the operators have a competency training are:

I. Increased job satisfaction and morale among employees
II. Increased employee motivation
III. Increased efficiencies in processes, resulting in financial gain
IV. Increased capacity to adopt new technologies and methods
V. Increased innovation in strategies and products
VI. Reduced employee turnover

b) Develop new Standard of Procedure (SOP)

Operators are not very clear to understand the current SOP each of machine. The operator running the machine by refer the manual because of the company does not provide and visualize a proper SOP for the operator referred to. The company has developed and visualized a new SOP for the operator to be referred before the operators running the machine. This improvement can contribute to achieve the objectives of this company.

7.0 CONCLUSION

This case study has achieved the objectives which are reducing the cycle time of the plastic bottle manufacturing by analyzing current state mapping to identify the bottleneck and create kaizen to make improvement toward the case study.

The recommendation that Chai Heng Plastics (MFG) SDN. BHD. can apply in other process in the company by reducing the lead time to improve their customer satisfaction. The company also recommended to monitor and implement the future state to avoid increasing number of lead time in process.

There is some limitation when doing this case study. This study does not cover overall process in the production area. This study just accesses to the bottle plastic manufacturing excluding bottle cap production. Besides that, time consuming also limited in order to implementing more improvement in the company. Apart from that, there was costly to make huge improvement in the company. Finally, this study has limitation on the images prove in order to show the improvement in paperwork.

For the future research, other researcher can study on how to reduce the defect of product in production. Based on the result, the defect also can affect on the lead time for the product to reach toward customers. For the next future research, by implementing and provide some tools from lean manufacturing or lean six sigma which can find the non-value-added activities on the inspection process and try to eliminate them.

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REFERENCES

Amni, S., & Binti Roslan, H. (2013). *THE EFFECT OF RECYCLED-HIGH DENSITY POLYETHYLENE (HDPE) MIXING RATIO ON THE TENSILE STRENGTH OF HIGH DENSITY POLYETHYLENE (HDPE) POLYMER*.

Belcher, S. L. (2007). Practical Guide To Injection Blow Molding. In *Practical Guide To Injection Blow Molding*. https://doi.org/10.1201/9781420014815

Bhasin, S., & Burcher, P. (2006). Lean viewed as a philosophy. *Journal of Manufacturing Technology Management*, *17*(1), 56–72. https://doi.org/10.1108/17410380610639506

Birkby, D. (2014). PET bottle handle—N.A. success story. *Canadian Packaging*. Retrieved from https://www.canadianpackaging.com/general/pet-bottle-handle-n-success-story-136251/

Garza-Reyes, J. A., Torres Romero, J., Govindan, K., Cherrafi, A., & Ramanathan, U. (2018). A PDCA-based approach to Environmental Value Stream Mapping (E-VSM). *Journal of Cleaner Production*, *180*, 335–348. https://doi.org/10.1016/j.jclepro.2018.01.121

Gaspar, L. C. (2019). *Pre-Feasibility Study PET BOTTLES MANUFACTURING UNIT Small and Medium Enterprise Development Authority Government of Pakistan*.

Liu, Q., & Yang, H. (2017). Lean implementation through value stream mapping: A case study of a footwear manufacturer. *Proceedings of the 29th Chinese Control and Decision Conference, CCDC 2017*, 3390–3395. https://doi.org/10.1109/CCDC.2017.7979092

Sundar, R., Balaji, A. N., & Satheesh Kumar, R. M. (2014). A review on lean manufacturing implementation techniques. *Procedia Engineering*, *97*, 1875–1885. https://doi.org/10.1016/j.proeng.2014.12.341

Tyagi, S., Choudhary, A., Cai, X., & Yang, K. (2015). Value stream mapping to reduce the lead-time of a product development process. *International Journal of Production Economics*, *160*, 202–212. https://doi.org/10.1016/j.ijpe.2014.11.002

Widiyati, K., & Aoyama, H. (2013). The ease of grasping to evaluate aesthetically pleasing pet bottle design. *Journal of Advanced Mechanical Design, Systems and Manufacturing*, *7*(5), 849–861. https://doi.org/10.1299/jamdsm.7.849