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EFFICIENCY IMPROVEMENT FOR SILKSCREEN PROCESS USING LEAN CONCEPT AT COLOROSO SOLUTION SDN BHD

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Abstract

This research describes the implement on efficiency for silkscreen process using lean concept. This research company is the apparel industry. It is one of the manufacturing sector in SME. The apparel industry need to have new strategies to focused the quality rather than quantity that can meet customer satisfaction. This research was conducted in Coloroso Solution. The problem they facing is work after office hours which is overtime hence they able to complete the customer orders without delay to ship to the customers. However, the overtime is additional expenses. There have 3 objectives of this research which are to analyze the current and future state VSM at silkscreen printing process. To identify value analysis that influence towards silkscreen printing process and to propose the potential solution in the silkscreen printing process that can improve it is efficiency. Value Stream Mapping (VSM) was the main tool to help reveal hidden and sources of waste. At the current state, the PCE was found 1.40%. However, it identifies 5 process that have higher cycle time number than takt time number. By that, the researcher focus on those 5 process. Each activity was being analyzed and categorized in VA, NVA and OVA activity. Eventually, the researcher gave several recommendations for reduce the cycle time and increase their efficiency.

Keywords: Apparel Industry; Silkscreen Printing Process; Value stream Mapping (VSM); Efficiency;

1.0 INTRODUCTION

1.1 Introduction

The apparel industry is one of the manufacturing sector in SME. The apparel industry divided into the number of process with different operations. The operation is one of the step in process by following the sequence that need to be done from the materials until finished good garment [3]. So, the apparel industry need to have new strategies to focused the quality rather than quantity that can meet customer satisfaction.

To improve manufacturing efficiency there are variety of lean tools that can applied such as Value Stream Mapping (VSM), 5S, Kanban and others it based on the problem and improvement of the company. Efficiency focus with doing the correct things the right way, minimize mistakes and losses. In term lean perspective, it need to improve of process cycle efficiency (PCE) by tackle the problem present in the process. The higher number of PCE will be more efficient in the process. [2] identified that to be globally competitive PCE should more than 25%. The aim of lean manufacturing is to reducing the waste with highly responsive to customer demand without additional the resources [1].

This research is focusing to implement the efficiency for silkscreen process at their company by using lean concept. Coloroso Solution is one of the manufacturing sector in SME. The Coloroso Solution been established since 2012. This company not only produce t-shirt production it also produced signboard & signage, uniform and others

2.0 OBJECTIVES

The objectives are:
- To analyze the current and future state VSM at silkscreen printing process.
- To identify value analysis that influence towards silkscreen printing process.
- To propose the potential solution in the silkscreen printing process that can improve it is efficiency.

3.0 METHODOLOGY

3.1 Data Collection

There are two types of data that researcher used which is secondary data and primary data. For primary data, consists of qualitative and quantitative. The qualitative is observation and interview (structured interview). While in quantitative is the data that need obtain for VSM by researcher self. The researcher using both method to completing this research. In addition, to support this research the researcher used secondary data also which is previous journal and book.

3.2 Visual Stream Mapping (VSM)

VSM as the main tools for this research. To accomplish the objectives in this research, the researcher use VSM methodology for guidelines the researcher to mapping the VSM for silkscreen printing process. In a depth VSM, there have current state VSM, process data and future state VSM.
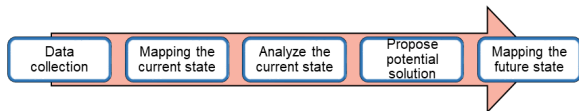

Figure 3.1 VSM Methodology

4.0 RESULT AND DISCUSSION

4.1 Current State VSM

By doing gemba walk, the researcher able to mapping the current state VSM of silkscreen printing process. The purpose of doing gemba walk because to collect all the information regarding the VSM data.
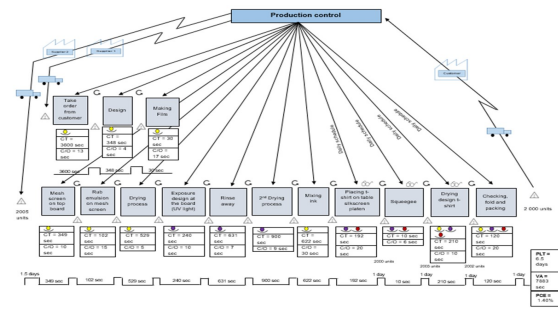

Figure 4.1 Current State VSM in Silkscreen Printing Process

Figure 4.1 shows the current state VSM of the silkscreen printing process. Once the customer order, the production control communicated electronically with suppliers to order the ink and t-shirt according to the customer demand. Shipment of raw materials coming from 2 suppliers which are ink and t-shirt. For the first supplier, they supply ink once a month while for the second supplier, they supply t-shirt by weekly until it meets the customer demand. Daily schedule production method was used in the process to complete customer demand. Taking order from customer and block preparation process was prepared in one day and do in a once per demand. From the mixing ink until checking, folding and packing were repeated process until achieved the demand. For silkscreen printing process only use one block for each color based on the design. There are three workers in t-shirt production. As shown in current state VSM, yellow operator refers to operator 1, purple operator is operator 2 and operator 3 in red color. The production using pull system which the production is based on actual demand and not forecast. From the process mesh screen until 2nd drying process, t-shirt is still raw material. While mixing until drying design, t-shirt it is WIP and lastly t-shirt had done in finished good, which is checking, fold and packing process before shipment to the customer. The process from taking order until the mixing process for block preparation, there is none inventory of t-shirt.

Takt time = (7.5×6×4) + (4×4) = (180) + (16) = 196 hours ÷ 2000 pieces = 352.8 sec/pieces
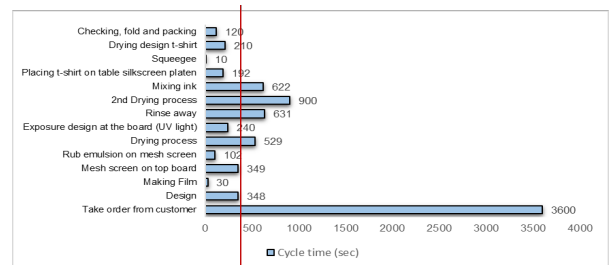

Figure 4.2 Difference Process with Number of Cycle Time

As indicated in Figure 4.2 shows the difference process with each number of cycle time. The red line refers as takt time. Researcher identify that there are 5 processes have higher cycle time than takt time number (352.8 sec) which are take order from customer (3600 sec), drying process (529 sec), rinse away (631 sec), 2nd drying process (900 sec) and mixing ink (622 sec). Takt time and cycle time are related. Hence, if number of cycle time in process more than takt time it means the process is not sufficient enough to keep up with demand. Based on situation, poor KPI, work over time would show a low performance of these process. According to the [4] stated that to improve their efficiency, cost base and customer responsiveness in manufacturing industry, it need to optimize the cycle time as much as possible. The reduction of cycle time gives big impact to the cost within the operation.

The value added time was determined are 7883 seconds, whereas production lead time is 6.5 days and PCE is 1.40%. The t-shirt production, produce according of demand and on time delivery. The contribution of high cycle time is consisting of preparation before printing the customers' t-shirt. High cycle time in silkscreen printing process consists of non-value added activity and waste.

4.2 Value Analysis

As shown in Table 4.1, each activities being analyzed and categorized in VA, NVA and OVA activity. The researcher focusing on five process because each process has higher cycle time number than takt time number. Those NVA can be eliminate, reduce or simplify their activity.

Table 4.1 Result of VA, NVA and OVA Activities

Activity	Before Improvement		
	VA	NVA	OVA
Process: Take order from customer			
Customer wait to entertain them		■	
Gather all information from customer			■
What shirt are you looking for?			■
How many t-shirt to order?			■
Did have any design for shirt?			■
When need to ship the shirt?			■
What colour on the design and colour of shirt?			■
What size shirt looking?			■
Take catalogue of design and colour		■	
Customer take a look the catalogue	■		
Open the system for order data from customer		■	
Payment process			■
Do invoice payment for customer			■
Print the invoice payment	■		
Take the print invoice		■	
Review back the order from customer to avoid any mistake	■		
Process: Drying process			
Take block to the drying rack		■	
Putting block at drying rack			■
Check the screen to ensure screen totally dry before the next process			■
Process: Rinse away			
Take block to the wash station area		■	
Water run through the screen			■
Emulsion fall off then start using water hose on the design			■
Check the design. Give a clear imprint of the design on the screen for the ink to pass through.			■
Process: 2nd drying process			
Take the block after rinse at wash station		■	
Putting block at drying cabinet			■
Check the screen to ensure screen totally dry before printing			■
Process: Mixing ink			
Review the colour that customer request			■
Searching the colour code for customize ink		■	
Try and error to get accurate colour		■	
Stir the mixture thoroughly	■		

4.3 Waste Identification

- **Motion**

Major problem related motion searching in mixing ink process. The operator will be searching the color code for customize ink. After that the operator will try and error to get accurate color that customer request. The operator spent time doing something that unnecessary moving that do not add value to the process. Because of that, there has higher cycle time number.

The block preparation in motion walking waste category because during the process if the block has defect such as pinhole, the operator need to tape which has hole or to restart block preparation process again. Which is start from the mesh screen on top board until 2nd drying process. The operator need to make sure the block does not have any defect because it gives poor result printing. This should be considering also the contribution of their overtime. The operator spent time unnecessary activity in order to finish the customer demand. This activity is something that customer unwilling to pay for. Moreover, the Figure 4.3 below shows layout of silkscreen printing production working area. By using spaghetti diagram, it able to show visual representation of the operators' flow. As shown in Figure 4.3, operator 1 is yellow, operator 2 is purple and operator 3 is red. Motion wasted caused by poor allocation of task between the operators and inefficient layout.
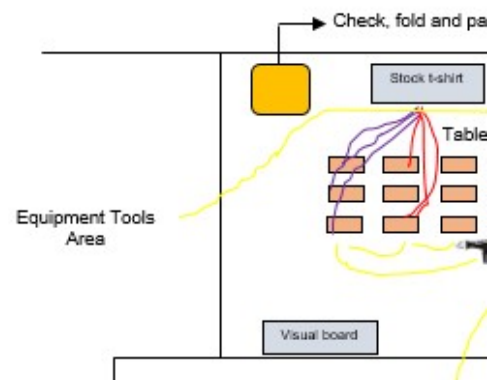

Figure 4.3 Silkscreen Printing Production Layout

- **Waiting**

In the process of taking order from customer, the customer will direct order for ordering t-shirt printing. The below show list of the non-value added activities that related of waiting:

➢ Customer waiting to entertain them.
➢ Take catalogue of design and color
➢ Open the system for order data from customer.
➢ Take the print invoice

- **Over processing**

In the process of mixing ink, there being try and error activities to get accurate color in order to meet customer request. It does not have accurate percentage to mix the ink hence that, operator stir excessive customization ink.

5.0 RECOMMENDATION AND CONCLUSION

The researcher emphasized of 4 waste and followed by potential solution that can reduced cycle time process.

5.1 Future Recommendation

Based on the result, the researcher will suggest several recommendations regarding the waste problems for further research. The below shows the future state VSM for silkscreen printing process.
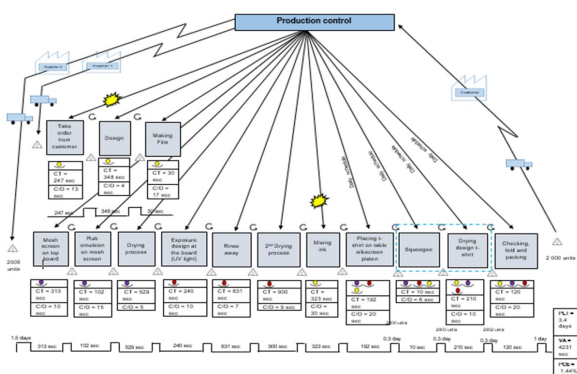
Future State VSM

Figure 5.1 Future State VSM in Silkscreen Printing Process

The future state VSM illustrated in Figure 5.1 is quite similar with the current state VSM. The researcher does not eliminate any process that have. It is because each process is critical main to produce t-shirt printing. In lean view the push system should replace with pull system. But the silkscreen printing process already using pull system. By that, the production does not have problem about the inventory. The researcher highlight of 4 waste as shown in Table 5.1. Subsequently, the symbol of kaizen burst has included at the future state VSM in Figure 5.1. Function of kaizen burst is focusing to the problems area. The researcher propose combination between squeegee and drying design t-shirt. The table platen has 72 tables. Each row need to 2 workers. If the workers are printing and drying at the same time it able reducing the higher cycle time. The Table 5.1 shows the recommendation for future research that can reduce cycle time number for the better performance in the production. If the non-value added activities being eliminated, reduced or simplified it directly minimal waste in the process.

Table 5.1 Recommendation for Future State VSM

Waste categories	Current State VSM	Cause	Effect	Future State VSM
Motion	Searching color code	Unorganized ink place	- Fatigue - Extra time	5S & color code system
Defect, Motion & Waiting	Block has pinhole	Poor skill block preparation	- Restart block preparation - Rework (Tape has pinholes) - Extra time - Fatigue	Utilization talent by sharing knowledge and skills

Waste categories	Current State VSM	Cause	Effect	Future State VSM
Waiting	Customer waiting to entertain them	The person in charge is busy with another task	Extra time	Utilization talent by sharing knowledge and skills
Over processing	Try and error method to get accurate color	Not have accurate percentage	Extra time	Pilot testing

As shown in Table 5.1 the waste is focused in the process of taking order from customer and mixing ink process. Actually there have 5 process beyond the takt time number. The reason the researcher focus only 2 process (taking order from customer and mixing ink process) because of the another 3 process (drying process, rinse away and 2nd drying process) are beyond on researcher expertise. Firstly, the process drying and 2nd drying process is important to consider with air movement, humidity and temperature factors. Secondly, rinse away process. The screen block need to wash out screen especially design area. Them took lot time to rinse away front and back side. Once done the rinse away, hold it up toward light to check either emulsion totally has been rinse away on screen or not. Check very details because it will affect the silkscreen printing quality. Therefore, the researcher not focus on that 3 processes.

For future state VSM the researcher suggests in a two process:

Taking order from customer
• Training from t-shirt productions' leader to among employees. • Take customer order by using digital through a website.

Mixing ink

• 5S
  ✓ Sort - Record what color in the system and disposed off.
  ✓ Set in order - Organized jar ink in designated location.
  ✓ Shine - Label in proper way and place it by frequency of using.
  ✓ Sustain - Put it back after use it. During the cleanup, the supervisor checks the jar ink place on the right position.
  ✓ Standardize - Change it. Make 5S as culture and corporate with workers.
• Color code system
  ✓ The color code system may record in Microsoft Excel. Color code system easily to identify where the basic color ink and customize color ink. The color code need to align with the ink at the rack place. Hence the ink at rack place need to 5S before to implement the color code system. The purpose to implement this to minimize the motion searching.
• Utilization talent
  ✓ Once the customer order been confirmed during the taking order process. The operator 2 should started placing mesh screen on the top board on the. On other hand, operator 3 start placing t-shirt for squeegee process. After operator 1 finish in part 1 (order), operator 1 can directly to start mixing ink process. So that it can minimize motion walking operator 1. Current state VSM illustrated that task operator 1 from the first until the sixth process
• Pilot testing.
  ✓ The purpose to mix custom ink experiment is to identify the accurate ratio between the color ink and plastisol ink. It is important to be accurate and only mix as much as needed to avoid excessive in custom ink.

5.2 Comparison Between Before and After Improvement

To achieved the efficiency in silkscreen printing process, the researcher had concluded the finding of VSM by comparing the value added time, cycle time

and motion (spaghetti diagram) for both current and future as shown below.

Table 5.2 Comparison Before and After Improvement Based on Cycle Time, Value Added Time and Motion

Cycle time (sec)	Taking order from customer		Mixing Ink	
	Before	After	Before	After
	3600	247	622	323

Value added time (sec)	Before	After
	7883	4231

Motion (Spaghetti Diagram)	
Before	After
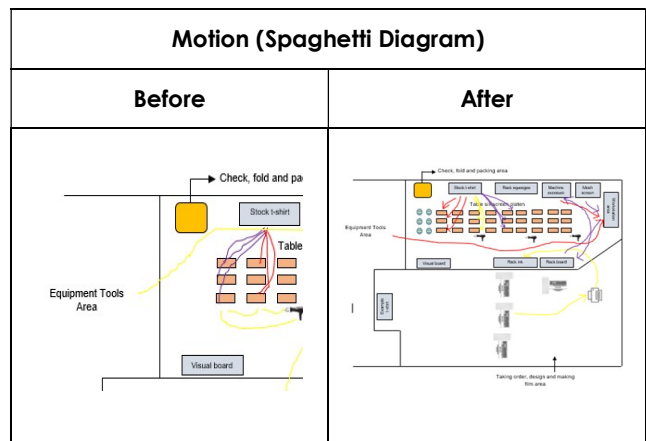
As can be seen in Table 5.4, the difference before and after improvement it obviously will be effect on production in terms of motion, time and waste. The cycle time of taking order from customer can be save in 3353 sec while mixing ink can be save in 299 sec. Therefore, the value added time will be reducing without have wasteful activity. The t-shirt production able to complete customer order without wasteful activity (muda) and can be proceed to the next order. In addition, excessive motion of each operator can be reduce and each operator do task in preparation before printing t-shirt customer.

In a nutshell, from all the finding that researcher obtain, it shown that the objectives have been achieved. The researcher improve efficiency in their cycle time process. Because those process have higher than takt time. Therefore, for reducing cycle time it required to eliminating or reduce non-value

added activity which not add value to the product. Last but not least, PCE silkscreen printing before is 1.40% and PCE silkscreen printing after was increase which is 1.44%

Acknowledgement

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