STUDY ON STREAMLINED PROCESS IMPROVEMENT BY USING VALUE STREAM MAPPING IN AUTOMOTIVE SEATING COMPANY: A CASE STUDY

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ABSTRACT: Streamlined process improvement is often one of the tools applied during the performance improvement plan at which it is an effective way of bringing about positives improvement to the processes. Value Stream Mapping is a qualitative tool by which described the process in detail about how it operates in order to create flow. Through the value stream is regarded as an important tool in the implementation of lean manufacturing at where it identifies the waste in system which paving the way for a successful lean implementation. The paper discussed the findings from the development of the Current State Value Stream Mapping (CSVSM) and the reduction in non value added time that can be obtained after the development of Future State Value Stream Mapping (FSVSM). The result of this paper indicates that development of the Value Stream Mapping from CSVSM to FSVSM has led to reduction in non-value added time from 11.76 days to 3.00 days. The suggestions of potential improvements opportunities are proposed for the Future State Value Stream Mapping after analyzing the problem statements.

KEYWORDS: *Time Study, Value Stream Mapping (VSM), Current State Value Stream Mapping (CSVSM), Future State Value Stream Mapping (FSVSM).*

1.0 INTRODUCTION

Streamlined process improvement is often one of the tools applied during the performance improvement plan at which it is an effective way of bringing about positives improvement to the processes. At the present time, manufacturing industries need to fully redefine their management in production systems in order to tackle the competitiveness demanded by the challenges from the current markets. Value Stream Mapping (VSM) can serve as a good starting point for any organization that wants to streamline the processes and it describes value stream as a collection of all value added and non-value added activities which are required to bring a product or a group of products using the same resources through the main flows, from raw material to the hands of customers [1]. The development of these tools and techniques will help to look towards the future state condition of the production flows.

In the case of this paper, the problem exists in the selected company is the challenges to develop better Value Stream Mapping tool in achieving breakthrough improvement in productivity. Even though company has develop Value Stream Mapping tool, there still a room of improvement for the performance of productivity as the Value Stream Mapping is a suitable tool in helping to streamline the process. No matter how good the management in the selected company, they cannot be successful without improvement in the process from time to time. There will be high possibility of producing waste in the production line area due to the ineffective in achieving good management. The specific objectives of this study are to understand the company's production process flow and carry out time study; to develop and analyze Current State Value Stream Mapping (CSVSM); and to develop Future State Value Stream Mapping (FSVSM) in order to identify potential improvements opportunities.

The current state mapping represents the reality picture of how material and information are processed before improvement activities started. Current State Maps are like picture and snapshot in time of how the value stream is actually operating at the given point in time [2].Current state of mapping was utilized to identify the reality of process and the sources of waste along the value stream. By having the mapping, it can help to identify the value added and non value added processes in any value stream in manufacturing plant. Current state map can be computed much easier if the future state goals are obvious.

Future state of value stream mapping is the map that should be map after a thorough analysis of current state of VSM has been done with all major waste have been identified, root causes have been diagnosed and potential improvement program listed. In FSVSM, if all identified improvement are to be implemented simultaneously can be a single document. If it is to be done in sequence over a period of time, thus several generations of future state map of the process shall be computed. Two distinct development of future state VSM are identified. The first is to view the value stream to be completely waste-free process or ideal state value stream which it is useful in setting an overall vision and direction. While the second approach is to do a roadmap on how to implement specific improvements to move in the direction of a better future state by looking at specific wastes, roots causes and improvement opportunities. It is adaptable to the specific circumstances of the organization and capable of generating resource requirement and performance statistics for both proposed future state map and existing operation [3].

II. METHODOLOGY

The development of VSM starts with formation of VSM team at where a team will be formed to get involved in this. When creating a value stream map, it is crucial to focus on one product family at a time. After the selection of product family, the project will continue with mapping the CSVSM. Current state mapping begins with understanding customer requirements. Key data points such as units per month, shipping frequency or schedules, hours of operations (available time), number of shifts worked, or any pertinent information around customer demand should be gathered before beginning the current state map. The time study will be conducted for the selected product. The methodology is continued with analysis of CSVSM at where it is a planning tool to optimize result of eliminating waste in production line. Analysis of CSVSM starts with calculation of takt time.

Identification of bottleneck process also has been carried out in order to improve line balance of the production line. Several line balance methods are identified and through the studies potential improvement steps will be discussed in the development of the future state. FSVSM is what each and every mapper wants to complete. It is the basis for action in a continuous improvement project. In this study, approaches such as line balancing through combine processes and the Kanban system will be carried out in order to balance the production line and maximize the production. Besides, identification of unnecessary processes also will be carried out to reduce waste and improve cost competitiveness of the product. Finally, after looking the entire work station and process through the development of CSVSM and FSVSM a thorough work plan should be developed with specific steps, goals and dateline. By having a clear work plan, it is possible to implement the improvement plan step by step.

III. RESULT AND DISCUSSION

A team has been formed to get involved in this VSM project with the leader is the plant manager of the ABC Company. Other team members are such as material specialist, production manager, process engineer, continuous improvement engineer and assistants. This VSM team will cooperate to develop the VSM. After that, the product family is selected to prevent the complexity in mapping the value stream at ABC company production line. It can be understood from Table 1 and Table 2 that there are four product families which are Honda City, Honda Civic, Honda Accord and Honda CRV can be identified from ABC company production line. Certainly, the Honda City product will be selected for this project due continual order for Honda City product. So, this product family is strategic in outlook of marketing gains at where this product received the highest demand and requirement from the customers.

The production line for Honda City product must be studied in order to get full understanding. The process flow for the Honda City which are workstation of Clipping (for 40% and 60%) ,workstation of RB1 (for 40%) , workstation of RB2 (for 60%) , workstation of RB3 (armrest assembly into 60% + steaming), workstation of armrest assembly , workstation of inspection , workstation of RC1 (clipping + steaming) and workstation of RC2 (clipping + steaming). The purchase orders are released from the customer which is Honda Malaysia Sdn. Bhd by using electronic data interchange and then Material Requirements Planning (MRP) system approve the monthly orders. The ABC Company production planning sends specific instructions and daily schedule to the first process and to the shipping departments. The production planning then released monthly purchase and daily purchase order to outside supplier. The other information is the work time for the ABC Company at where it operates two shifts a day and 8.5 hours every shift. The customer demand for the Honda City is 204 sets per day and the stock is 25 sets. The inventory for workstation of Clipping is 30 units, RB1 is 630 units, RB2 is 630 units, RB3 is 1000 units, armrest assembly is 60 units, inspection is 15 units, RC1 is 25 units and RC2 is 25 units. The finished goods inventory is 65 units at where it will undergo shipping with 34 trips in a day for Honda City product. Table 3 shows the cycle times that have been taken for five times for each workstation by using the stopwatch at the real production line. The cycle time is taken when the employee starts the work until he or she end the work for the production of Honda City product. Appendix A shows the complete CSVSM that has been developed after collection of all the data that are needed. From the Current Mapping, it shows that the total non-value added time for the current map is 11.76 days and the total value added time is 921.80 seconds. The analysis of the CSVSM starts with the takt time calculation.

The analysis of the CSVSM starts with the takt time calculation with the working time of two- shift operation in all production departments. The other information is such as 8.5 hours every shift, two 15 minute breaks during each shift, 30 minutes for lunch and manual processes stop during breaks, two shift in a day and customer demand is 102 sets / shift. Takt time calculation such as

Available working time: 34200 s (9.5 hours) – 1800 s – 1800s = 30600 seconds per shift
Customer demand = 102 set / shift
= 306 units/ shift (40%, 60%, cushion)

$$\text{Takt time} = \frac{\text{Available working time}}{\text{Customer demand}} \quad (1)$$

$$= \frac{61200 \text{ s/day}}{204 \text{ sets/day}}$$

$$= 300 \text{ seconds}$$

After the takt time calculation, the waste of waiting can be seen clearly in every workstation that has been developed. This waste of waiting will be the main waste that needs to be eliminated or reduced due to the cycle time for every workstation is differing large from the target time (takt time) of 300 seconds. Line balancing is done to eliminate waste through process kaizen to bring work content under the takt time ceiling. Line balancing is an effective tool to improve the throughput of assembly lines and work cells while reducing manpower and save the space of the workstations. Below are the proposal for the line balancing based on the cycle time and takt time for the Honda City workstations. For this study three ideas has been proposed for Honda City production line. However proposal three has been selected were Kanban application is adopted with minimum numbers of operator and workstation. The proposal 3 is used to develop the potential improvement for the development of Future State Value Stream Mapping.

Table 1. Product family selection for Honda City and CRV.

Process / Product	Clipping (40% and 60)	RB1 (Assembly 40%)	RB2 (Assembly 60%)	RB3 (Armrest 60%)	Armrest assembly	RC1 (Clipping)	RC2 (Clipping)	RC1 (Clipping 60%)	RC2 (Clipping 40%)
2 PK S City	×	×	×	×	×	×	×		
2 PK E City	×	×	×	×	×	×	×		
2 WS CRV	×	×	×	×	×			×	×

Table 2. Product family selection for Honda Accord and Civic.

Process / Product	Clipping	RB1 (Assembly small parts)	RB2 (Assembly 100%)	RC1 (Clipping)	RC5 (Wing side)
2 QZ 2.0	×	×	×	×	
2 QZ 2.0 VTI -L	×	×	×	×	
2 QZ 2.4 VTI -L	×	×	×	×	
2 HC 1.8 Civic	×	×	×	×	×
2 HC 2.0 Civic	×	×	×	×	×

Table 3. Cycle time at the process.

Process	Clipping	RB1	RB2	RB3	Armrest Assembly	RC1	RC2	Inspection
Average (s)	139.80	179.00	157.40	146.80	113.00	204.20	198.60	234.40
Actual (s)	142.93	143.71	123.20	103.07	103.07	248.20	248.20	-

A. Potential Improvement 1 (Inventory reduction by implementing Kanban)

The Kanban system enables the rear seat assembly to reduce the inventory. As the result, lead time will be reduced and the turnover ratio will be increased. The inventory for the inspection for the processes of the Clipping, RB1, RB2, RB3 and Armrest assembly is reduced from 15 units to 5 units. The bottleneck cycle time for the operator is 259.80 sec from the proposal 5. An inventory calculation is shown as

By using the calculation below, the units of inventory for each workstation can be identified. Table 4 below shows the new units of inventory after applying the Kanban system.

Actual units of inventory from current map = 15 units of semi-finished goods
(X new) units = 5 units of semi-finished goods
X= new units of inventory

Example calculation for Clipping (for 40% and 60%):
30 units of inventory = 15 units of semi-finished goods
X_1 units = 5 units of semi finished goods
X_1 = 10 units of inventory

259.80 sec = 1 unit
5 units =>259.80 sec x 5 = 1299 sec (22 min)
(17 hour) 1020 min / 22 min = 47 trips of goods delivered in 1 day to storage

From customer demand for 1 day = 204 sets finished goods
Maximum output for 1 day = 47 trips x 5 units of goods
= 235 sets

Table 4. New units of inventory.

Process	Clipping	RB1	RB2	RB3	Armrest Assembly	RC1	RC2	Inspection
Actual unit	30	630	630	1000	60	25	25	15
New unit	10	210	210	333	20	8	8	5

From above calculation, it shows that in 1 day extra 31 sets of Honda City products will be produced. In order to follow the customer demand, it can be proposed that when the production of the products reached 204 sets according to the customer demand, the production line can be stopped. By doing this, the time for producing the products can be saved.

B. Potential Improvement 2 (*Line balancing*)

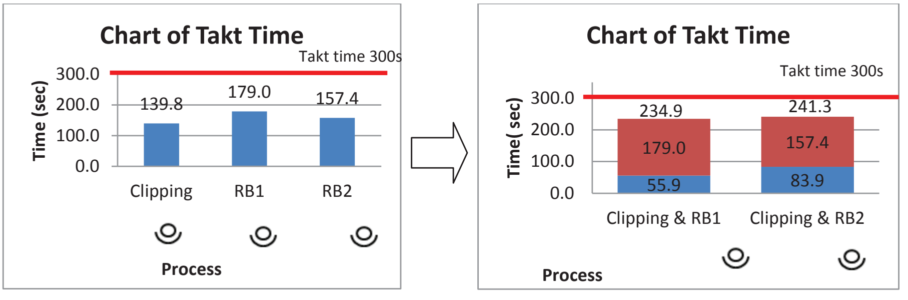

Fig. 1. Chosen line balancing proposal for future value stream mapping.

Figure 1 shows the line balancing that have been chosen for the proposed future state value stream mapping at where 3 processes will be combine to 2 processes with the consideration of the takt time. The cycle time for the 3 processes which are Clipping, RB1 and RB2 have quite a lot of difference from the takt time of 300. Line balancing can be done on these 3 processes at where they will be combine into 2 processes at which 1 process will be Clipping and RB1 and the other process will be Clipping and RB2. The reason for doing this line balancing of separating the clipping process to 2 processes is because the Clipping process are consumed of clipping for 40% of rear back and 60% of rear back. With the combination of the clipping with the rear back assembly, it will become a complete process with Clipping (40%) + RB1 process will do the assembly of the rear back for 40% while Clipping (60%) + RB2 process will do the assembly of the rear back for 60%. This will help to reduce the waste of motion and reduce the cycle time of the operator. The combination of the process of Clipping (40%) + RB1 and Clipping (60%) + RB2 are acceptable because the total cycle time for both are still below the takt time of 300 s.

This will help to reduce the waste of motion and reduce the cycle time of the operator. With this also the operator can concentrate more on their work and this will help to improve the cycle time. By doing the line balancing, it can help to reduce some of the waste such as the waste of motion from the operator, the waste of space at where 3 workstations have been reduced to 2 workstations and finally reduce the manpower of 3 operators to 2 operators.

Calculation of separation for the clipping process:
From the total cycle time of Clipping process which is 139.80 s, the assumption will be made by which with the assumption of taking the 40% for the clipping of 40% of the rear back and taking the 60% for the clipping of 60% of the rear back.

$$\frac{40}{100} \text{x } 139.80 \text{ s} = 55.9 \text{ s}$$
$$\frac{60}{100} \text{x } 139.80 \text{ s} = 83.9 \text{ s}$$

Combination of the process:

Clipping (40%) + RB1 = 179.0 s + 55.9 s

= 234.9 s

Clipping (60%) + RB2 = 157.4 s + 83.9 s

= 241.3 s

From the calculation above, the combination of the process of Clipping (40%) + RB1 with the cycle time of 234.9 s and the combination of the process of Clipping (60%) + RB2 with the cycle time of 241.3 s are acceptable because the total cycle time for both processes are still below the takt time of 300 s. This potential improvement of doing the line balancing for the workstations is one of the major improvements that can be done of on the Current State Value Stream Mapping in order to come out with more efficient Future State Value Stream Mapping. Improved the management is important, but improved the production line by eliminating or reducing the waste that occurred in the production line of Honda City is also important to be considered.

C. Potential Improvement 3 (Process combine)

Figure 2 shows the cycle time for the workstation of RB3 (armrest assembly into 60% + steaming) is 146.80 second and the cycle time for workstation of armrest assembly is 113.00 seconds. The two processes of RB3 (Armrest assembly for 60%) and Armrest Assembly will be combined to become one workstation with the cycle time of 259.8 s .This will help to reduce the number of operator from 2 operators to 1 operator at where it is a kind of improvement that can be done on the Honda City production line. By doing the process combined, it can help to save the space and number of operators at where 2 workstations have been reduced to 1 workstation.

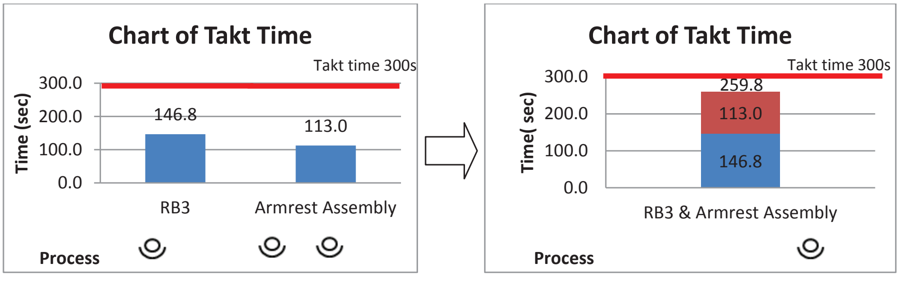

Fig. 2. Combinations of two processes for optimize workstation.

D. Potential Improvement 4 (Eliminate unnecessary process)

The workstation of RC1 (clipping + steaming) and the workstation of RC2 (clipping + steaming) have deliver the same work to the production line which is clipping and steaming the rear cushion of the Honda City seat. Since these two workstations have the same work functions, it will be unnecessary to have two workstations at one production line that do the same work. Besides that, one workstation can cover the whole work for the clipping and steaming for the rear cushion at where one process will be eliminated at which there will only left one workstation that do the work for the clipping of the rear cushion. Appendix B shows the development of the FSVSM after the potential improvements have been done. The total of non-value added time for the future map will be reduced from 11.76 days to3.00 days and the total value added time is 735.50 seconds. The work plan for the developed Value Stream Mapping is to implement the proposed potential improvements that have been done and once have a sense for the basic order in which the need to implement the elements of the future state vision. Continuous improvement is the success for the developed Value Stream Mapping at which it provides the methodology necessary to capture the opportunity for change.

Lean simulation game is a game at where the participants will do the real simulation by according to the CSVSM to the FSVSM at which there will be reduction in the lead time from converting the current map to the future map. Lean simulation game used by creating dummy for every workstation to process part with purpose to visualize the CSVSM and FSVSM. Cycle time for every workstation is determined by assuming 1 minute equal to 1 day. Lean simulation game required a space in order to visual the process for traditional and future layout. Before starting the simulation, the person in charge will explain briefly about the rules and regulations when conducting this lean simulation game since the purpose of having this training in to view the effectiveness in the reduction of lead time when there is changing in the layout. There will be two layouts for this real simulation which is traditional layout and the future layout. The simulation for the traditional layout requires 5 operators with the normal lead time will be 5 days which will be represented with 5 minutes at where 1 day will represent 1 minute. The result from the simulation is the lead time is 6 days (6 minutes) at where it requires overtime of 1 day (1 minute). The waste that occurred in this traditional layout simulation is bolt hardening workstation is facing waste of waiting due to the long processing time of bolt hardening and do not have any improvement like Kanban card and jig.

The future layout at where this layout simulation requires 4 operators with the lead time of 5 days (5 minutes). By simulate the future layout, it shows that there is no overtime in the work process. The improvements are using the Kanban card, using the Heijunka Box to make sure the operators produced the product according to the order by using colour, changing the position of the final assembly workstation to between the bolt hardening and painting, and using the jig to fasten the work at the final assembly workstation. Bolt hardening operator will do the assembly work while waiting for the bolt to harden. Table

5 shows the table of comparison for the two layouts simulated in the lean simulation game. The activities will be conducted according to the layouts at where first simulation will start with the traditional layout and the lead time for the simulation will be recorded. Finally, the simulation will end with the future layout with the lead time also will be taken down after the simulation complete. It shows that there is reduction for lead time from 6 days to 5 days at which the future layout is the layout that need to be proposed in the production line in order to have a smooth process flow. By conducting this lean simulation game, the uses of the VSM tools in helping to increase the productivity of the product at the production line will be more clearly defined.

Table 5. Comparison for two layouts.

Criteria	Traditional Layout	Lean Layout
Lead Time	6 days	5 days
Overtime	Yes	No
No. Of operator	5	4
Improvement	No	-Kanban card -Heijunka box -Used jig at final assembly -Line balancing

IV. CONCLUSIONS

The task of this project is the application of Value Stream Mapping to map the current map and future map for the selected product at ABC Company. The methodology is used as a roadmap to conduct this project. The objectives of the company have been achieved at where the Value Stream Mapping for the Honda City production line have been developed with some potential improvements done on it. The development of the VSM on the selected production line helps the company to do reduction in terms of non value added time and wastes that occurred at the Honda City production line. VSM has shown itself to be a suitable tool for redesigning production systems. This is proven from the results obtained in this application project .The objectives of this study are achieved after the completion of this project. By using the information provided, considering the whole stream using VSM help to manage and eliminate the occurred wastes and as well as reduce the non value added time in the Honda City production line. Finally, an implementation plan on the developed VSM will be done for the selected production line.

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