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COMPUTERIZED VALUE STREAM SYSTEM (CVSS) TO REDUCE WASTE IN LEAN MANUFACTURING OPERATION

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Abstract

Lean manufacturing is a popular method of acquiring efficiency in manufacturing environment. Value stream mapping (VSM) is one of the methods that can be used by practitioner to support lean. VSM method is also a common method to identify waste and determined causes of the waste through the value stream mapping approach and propose solutions to improve workplace environment. This project is an attempt to computerize the normally manual VSM process. Computerize value stream system (CVSS) is basically a method which is an internet networking system combined with traditional concept of value stream mapping method used at manufacturing company to reduce wastes. This paper summarizes the way to apply an internet, online and network based of an efficient computerize value stream system to improve operation value of the manufacturing company. This paper reviews the design of the package that will replace the manual method of doing VSM. The system is tested in a real shop floor environment and found to be successful.

Keywords: value stream mapping, CVSS, lean manufacturing system, increase productivity, waste reduction

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1. Introduction

Traditional manufacturing practices are the thing in the past. Cyber or computerized manufacturing is introduced to increase productivity, shop floor networking to enable data collections and sharing among users within and outside the enterprise, promote efficiency and add value to products. Cyber manufacturing is a manufacturing process and engineering which adopt a networking and make full use of computerization. This allows real-time entries of system data for all the activities that occurred on the shop floor.

This paper explored and investigated how traditional VSM can be computerized and integrated into a computerized manufacturing system. It can be used as a method to reduce non value added activities and develop an efficient system to improve operation value of a manufacturing company.

2. Lean Manufacturing

Lean is defined as the systematic removal of waste by all members of the organization from all areas of value stream [1]. Lean is often referred to as a cost reduction mechanism. Lean strives to make organizations more competitive in the market by increasing efficiency, decreasing costs incurred due to elimination of non-value added (NVA) steps and efficiencies in the processes as well as reducing cycle times and increasing profit to for the organization [2,3]. Lean effectiveness is when it produces exactly what is needed in the right amount needed and when it is needed. Lean manufacturing is aimed at elimination of waste in every area of production including customer relations, product design, supplier networks and factory management [4,5].

3. Computerize Value Stream Mapping (CVSS)

Value Stream Mapping is one method used to eliminate waste in lean system [6,7]. This is considered as an important tool for efficiency [8]. Value stream mapping from the standpoint of traditional view is currently mostly manual form filling operations, with the use of basic tools for most of the process or operations. However, the traditional VSM has come of age, and has now been implemented in modern practices like the application of modern machinery, networking system, new technology and new method to increase productivity [8].

CVSS is a system or software that can auto calculates total amount data inserted for every process related to VSM. All data that can be auto calculated are total processes of VSM, total of cycle time (CT), total of operator needed, total time of waiting time (WT), total of work in progress (WIP), total of lead time (LT) to finish process from raw material till finish goods, total non-value added time

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(NVA) and total of value added time (VA) as shown in Fig. 1.

CVSS was created as software that can be used at any of manufacturing company that applies VSM and lean method to reduce waste occurs during manufacturing process. CVSS software calculates takt time for every process of manufacturing by inserting the data related into the column of data table provided by the software. To calculate takt time, user must have a complete set of data consisting of customer demand per day and working hours per day. Using this format, takt time for whole process of production or every process at particular area can be calculated automatically.

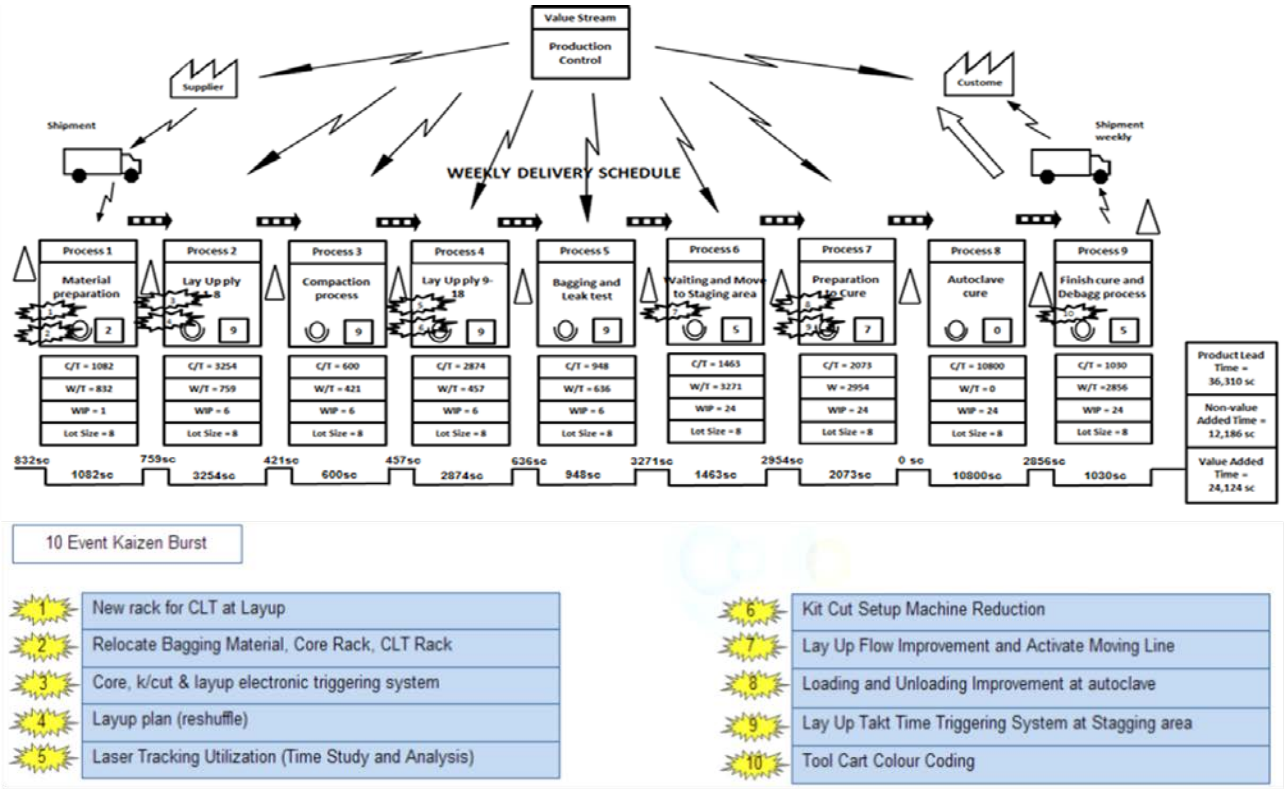

Fig. 1. Current state of CVSS

The ideal times of production that meets the demand and customer requirement. "Takt" is a German word meaning "beat." Takt time is also the time needed to produce one product to meet customer requirement. Therefore, for this process, takt time calculated as in Fig. 2.

Costumer demand per day: 20 panels
Working time: 3 shift per day (8 hours)
Break time: 1 hour per shift
Available time: 21 hoursper day

$$Takt\ time = \frac{Net\ operation\ time}{Costumer\ demand}$$

$$= \frac{8\ hours - 1\ hour * 60\ \text{min}}{20\ panels}$$

$$= 21\ \text{min}\ per\ panel$$

$$= 1260\ \text{sec}ond$$

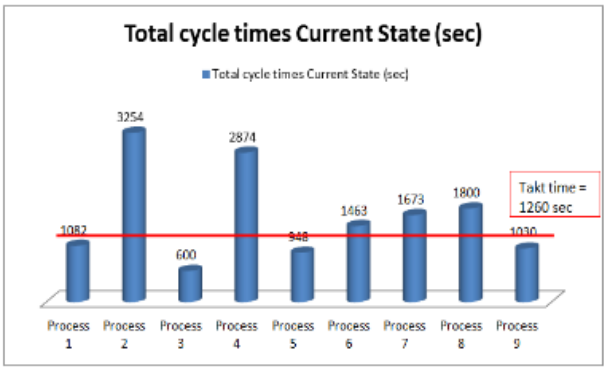

Fig. 2. Total cycle times current state of CVSS

From Fig. 2, we can see clearly the cycle time for each process exceeded the takt time which is 1260 seconds. So, that mean, a time to produce a product is more than available time allocated. From Fig. 2, we know this is due to the bottleneck that occurs in those processes respectively. Therefore,

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VSM is a very good method to reduce all the cycle time to meet takt time to produce efficient and efficiency working time.

The purpose of current value stream mapping is to create a picture of how products flow through the value stream which is from raw materials to the customer's arm. For this research, Fig. 2 shows the current state map of the work processes as they currently exist in the company. It is important to understand the needs for changes and also where an opportunities lie. From the flow also, there are many items that can be identified and there will be room for improvement for solving problems.

Fig. 3 shows the total lead time of manufacturing process at studied company. Lead time is the total operating time to complete a cycle of product before moving to another product. Cycle time is total time require to complete task or process in making a product. From the result, we can estimate how much time needed to complete 1 unit of panel before it move to another process. Lead time also includes value added time and non-value added time. Table 1 shows summary of VA and NVA times.

Table 1. Summary of VA and NVA times

Total Operation Time					
Operation	Process	VA time	NVA time	Cycle time	% Cycle time (to be eliminated)
1	Material preparation	1082	832	1914	43.47
2	Lay up ply 1-8	3254	759	4013	18.91
3	Compaction	600	600	1200	50
4	Lay up ply 9-14	2874	457	3331	13.72
5	Bagging and leak test process	948	636	1584	40.15
6	Wait and move to staging area	1483	3271	4734	69.1
7	Preparation to cure & loading	1673	1054	4627	58.76
8	Autoclave Cure	10800	0	10800	0
9	Unloading and debag process	1030	2854	3886	73.49
	TOTAL LEAD TIME	23724	10465	34189	

From Table 1, the total lead time for the whole operation is shown. Total lead times for this process are 34,189 seconds. Non value added contributes 10,465 seconds (30.61%) that is used for non-productive operation. The time used for creating value product which is value added time is 23,724 seconds (69.39%). As company to manufacturer makes the profit, this kind of waste will increase the operation cost and also time for making product. The waiting time that occurred during manufacturing process is a major cause to the higher non value added times. This problem can be look at certain production area that contributes lots of waiting time and become bottleneck to the next operation process.

From the existing problems, the study will be conducted to minimize any possibility that can cause non value added operation and increase value added processes. CVSS will be used as a method to reduce the waste occurred.

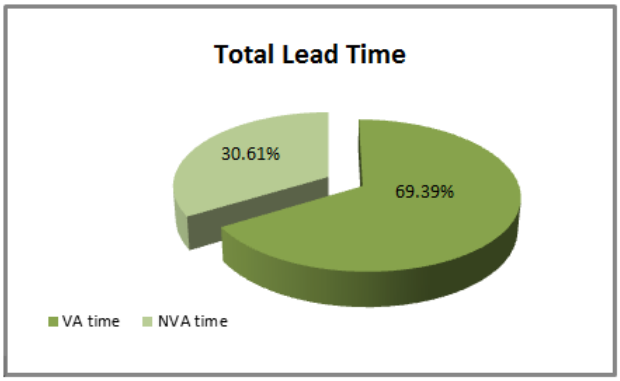

Fig. 3. Total lead time

From the chart, as a manufacturing company that makes profit, they need to eliminate or at least reduce their non-value added activity to make profits. This project deal with process improvement in the company using various Lean Manufacturing tools such as 5S and Value Stream Mapping. The main reason of using these tools is to identify waste in value streams in order to find an appropriate ways of elimination or at least to reduce it. Fig. 3 show total lead times of manufacturing process.

4. Summary of Problems and Actions Taken

From observation have been conducted, researcher found lots of problem occurs during company operation. Discussions of all waste identified and action taken for each Kaizen burst are as shown in Table 2 to Table 11.

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Table 2. New Rack for CLT (Circle Laminate Template) at Lay Up area

New Rack for CLT (Circle Laminate Template) at Lay Up area		
Waste identified		Action Taken
Complexity	difficult to take because of the ways it keep	Design new model of CLT rack
Defect	defect CLT surface because of the friction between them	Make partition to eliminate friction
Time	use lots of times to find and take before use	Partition as easy way to take out CLT from rack

Table 3. Relocate Bagging Material, Core Rack and CLT rack

Relocate Bagging Material, Core Rack and CLT rack		
Waste identified		Action Taken
Labor	need more operator to push heavy and big tool for cure at autoclave.	Replace broken tool cart tyre with new tyre.
Space	waste space because of the unimportant type of material such as prepreg box, sealant box etc.	Do 5S to manage space properly
Idle Material	Many pre preg carts pending at lay-up space. Need more space to keep pre-preg carts at lay-up area.	Cut pre preg according to schedule. Avoid idle material.

Table 4. Core, Kit Cut and Lay up Electronic Triggering System

Core, Kit Cut and Lay up Electronic Triggering System		
Waste identified		Action Taken
Complexity	Have no specific report/format for triggering Kit Cut and Core Supply to lay Up	Came out with specific format which is can trigger Core and kit Cut
Visual Control	No single visibility to coordinate, expedite and have the Kit Cut, Core and Tooling to be synchronised	To implement electronic control of operations via single electronic report or display
Labor	Have no specific PIC for each area to Log in the system	Area manager to identify the name of the PIC and forward it to Information System department

Table 5. Lay up Plan Reshuffle

Lay up Plan Reshuffle		
Waste identified		Action Taken
Idle Material	Many pre preg carts pending at lay-up space. Need more space to keep pre-preg carts at lay-up area.	Kit Cut machine cut pre-preg according to plan/ demand
Overproduction	Kit cut machine produce/cut pre-preg more than requirement. A lot of pre-preg cart pending at lay-up	Reschedule Kit Cut operation to follow demand.
Transportation	Heavy and big tool need to push for long distance to autoclave	Change big tool lay up line in middle of lay-up up area, near to push carts to autoclave area.
Labor	Need more operator to push heavy and big tool for cure at autoclave	Replace broken tool cart tire with new tire.

Table 6. Laser Tracking Utilization

Laser Tracking Utilization		
Waste identified		Action Taken
Complexity	Too much access ply compare actual size required.	Cut ply according to size required
Overproduction	Produces ply more than schedule plan. Not enough Laser capacity.	Kit cut produce ply according to demand
Transportation	Heavy and big tool need to push for long distance to Laser Projector.	Move big tool line near to autoclave

Table 7. Kit Cut Machine Setup Reduction

Kit Cut Machine Setup Reduction		
Waste identified		Action Taken
Complexity	Cutting and writing on ply in one direction. Dangerous for operator to pick ply when machine running.	Cut and write ply in one direction.
Overproduction	Kit cut machine produce/cut pre-preg more than requirement. A lot of pre-preg cart pending at lay-up	Cut ply according to demand from lay up
Material	Waste in material because operator have tendency to pull preg a lot more than required cutting region (when not cutting full table)	Educate or train employees to avoid pulling excess material.
Time	Time consuming for setting up programme. Operator scans by batch and call out program one by one.	Reduce setup time by reschedule scanning system

Table 8. Layup Improvement and Activate Moving Line

Layup Flow Improvement and Activate Moving Line		
Waste identified		Action Taken
Complexity	complexity of movement and process flow for HEXCELL program	re lay-out HEXCELL program lay up area
Transportation	Laminating Mold always queue before entering lay up room	Straight way for LM from entering door to moving l;ine
Space	waste space because not important type of material such as prepreg box, sealant box etc	Do 5S to manage space properly
Time	long time to take CLT due to long distance	Reschedule time for entering time

Table 9. Loading and unloading improvement at Autoclave

Loading and unloading improvement at Autoclave		
Waste identified		Action Taken
Complexity	Difficult to load the autoclave rack due to condition of rail	Repaired and extend Autoclave rail for A/C 1 & A/C 2
Labor	Constrains of manpower due to same person doing loading, unloading, put LM on the autoclave & debag process	Manpower has been arranged equally - request additional manpower (8 person) to support 24/7 schedule
Defect	Found surface depression issue suspected by vacuum coupler during loading process	Retrained all autoclave operator based on Process resident work plan (PRWP)
Time	Take time for loading. Due to damage or leaking vacuum hose, problem of vacuum port, leaking of final bagging, undetected Tc wire	checked and repaired vacuum systems at all autoclave (piping inside autoclave & vacuum hose itself)

Table 10. Layup takt time triggering systems at staging area

Layup takt time triggering systems at staging area		
Waste identified		Action Taken
Labor	Operator walk & take the material by their own (stryder are not effectiveness)	Retrained to all stryder (the functioning of water stryder)
Transportation	Have no enough tool cart & it can effect on daily output	tool cart will run smoothly when the bus schedule have been followed
Time	Late supply of TC Wire	autoclave bus schedule consistently followed

Table 11. Tool cart color coding

Tool cart color coding		
Waste identified		Action Taken
Transportation	Have not enough tool cart & it can effect on daily output	Maintained tool cart properly
Time	Operator cannot concentrate on their job because need to walk to find material	Centralize material area. Easier for operator to pick up.

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5. Future State of CVSS Analysis

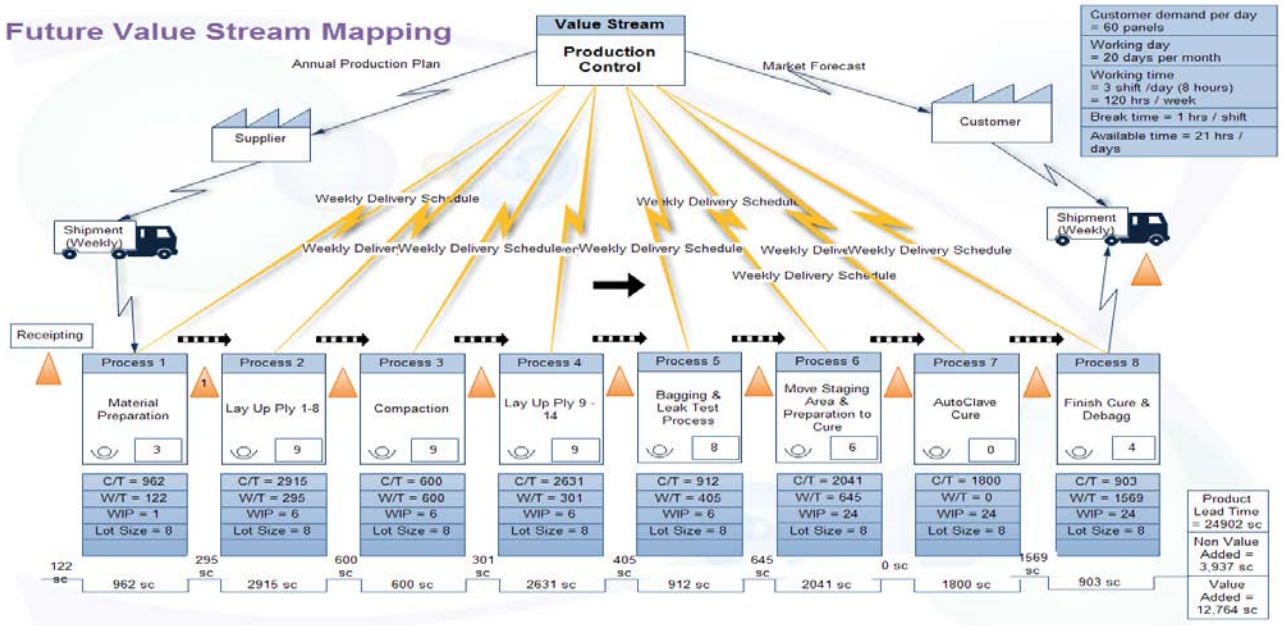

Fig. 4. Future State of CVSS

From the problems identified, kaizen burst have been done by Kaizen team for future state of value stream mapping in order to improve their operation. The comparison between current state of value stream mapping and future state of value stream mapping is shown in Table 12 below.

Table 12. Total time current and future CVSS

Process	Total cycle times			
	Current State (sec)	Future State (sec)	Total reduce	% reduce
# of Operation	9 processes	8 processes	1	12.5
Process 1	1914	1084	830	43.36
Process 2	4013	3210	803	20.01
Process 3	1200	1200	0	0.00
Process 4	3331	2932	399	11.98
Process 5	1584	1317	267	16.86
Process 6	4734	2686	4775	53.65
Process 7	2727			
Process 8	10800	10800	0	0.00
Process 9	3886	2472	1414	36.39
Total	34189	25701	8488	

From Table 12, comparison between current state and future state of value stream mapping is shown. Before kaizen burst is implemented, the total operation is 9. But when kaizen burst have been applied to all the processes, 1 process operation have been reduce but still producing the same amount of product. This mean, the total cost and times for the operation have been reduced. This is what lean manufacturing aiming for.

From the analysis that have been done for current state of CVSS and the future state of CVSS, there are some reduction of time identified such as waiting times, total operation time and also total NVA time. Comparison of waiting time, total operation time and NVA time for current and future state is shown in Table 13.

Table 13. Total waiting time

Process	Total waiting times			
	Current State (sec)	Future State (sec)	total reduce	% reduce
# of Operation	9 processes	8 processes	1	12.5
process 1	832	122	710	85.34
process 2	759	295	464	61.13
process 3	600	600	0	0.00
process 4	457	301	156	34.14
process 5	636	405	231	36.32
process 6	3271	645	3680	85.09
process 7	1054			
process 8	0	0	0	0.00
process 9	2856	1569	1287	45.06
Total	10465	3937	6528	62.38

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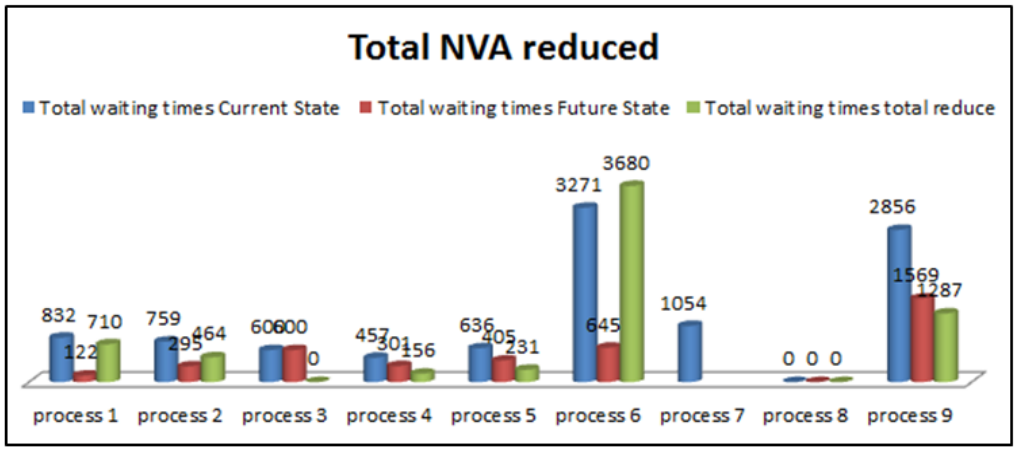

Fig. 5. Total NVA reduced

From Table 13 and Fig. 5, total waiting times for whole processes are 10,465 seconds for current state of value stream mapping and 3,937 seconds for future state of value stream mapping. From Fig. 5, the total waiting times reduction from process 1 till process 9 were 6,528 seconds or 62.38%. It shows that CVSS can help lots of NVA times to reduce.

6. Conclusion

From the results of this paper, it is proven that CVSS can help manufacturing company to reduce their waste in production. Thus it will help the company to gain more profit after applying CVSS in their current production system. Most of all, the company made very good improvement towards lean manufacturing system by applying most of lean characteristic to increase their effectiveness and efficiency. In this paper, comparisons analysis was done between current state of value stream mapping and future state of value stream mapping using CVSS. The cycle times and waiting times analysis is done to reduce the total cycle times for the whole processes. This involved Kaizen system in order to suggest improvements.

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