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Value Stream Mapping (VSM): A Key Tool for Execution of Lean Principles in a Small Scale Organization

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Abstract
Manufacturing organization in current scenario aims at higher productivity with effective utilization of available resources. Currently all manufacturing organization are looking at minimizing wastages from the manufacturing cycle of a product. Reduction in wastages is a key aspect of Lean Philosophy. Value Stream Mapping (VSM) is one of the lean manufacturing tool which is very beneficial for small and medium scale organization .VSM is used for identification and visualization of value added and non value added activities. VSM is very effective for improvement in lead-time and helps to reduce overall cost of production.This paper describes use of VSM in a small-scale Job type organization. During this investigation a current state map for organization is drawn. After making its analysis, a future state map is drawn with suggestions for improvement in the shop floor of the organization.

Keywords: Lean;Value Stream Mapping;lead time;Cycle Time

Introduction

In this global competition one must be able to meet unprecedented market changes; organizations must not only design and offer better products and services at the same time need to improve their manufacturing operations. One of the strategies is by deploying lean manufacturing practices that can be used to improve the operational performances. Lean manufacturing basically refers to manufacturing processes without waste. Waste is anything other than the minimum amount of equipment, materials, parts, and working time, which absolutely are vital to production [1].
Many industrial organizations have to change their business procedures in order to be compatible with new manufacturing philosophy. Internal and external information are the most important resources in today's manufacturing environment. A big challenge every organization facing today is collecting information in the right way and in real time. Collecting information from manufacturing processes is mostly adapted for mass production. For every organization product cost is the crucial fact for management. Many companies are not able to recognize and identify complete value stream [2].
Value stream mapping is a visualization tool used to analyze the flow of materials and information required to bring a product or service to a customer. This is basically a communication tool, but is also used as a strategic planning tool and a change management tool. The foundation of the Toyota way is based upon identifying and eliminating waste in all work activities. If we look each and every process as a time line of activities, material and information flows and chart the process from start to end, we will find a depressing amount of waste – usually far more waste than value-added activity. Apparently these reductions of waste are being handled with a short term strategy called the kaizen. A well executed kaizen workshop can be a step in teaching people what is possible. But this has to be handled as a longer term strategy for developing lean value systems and ultimately a lean enterprise. Value stream mapping is one such long term philosophy lean technique used to analyze the flow of activities and information currently required to bring a service to a consumer [3]. In manufacturing industries there are systems or process flows that cannot be seen or visualized easily by the naked eyes. Value Stream Mapping (VSM) can provide a good view. In VSM map identifies source of wastes and improves the system by eliminating the wastes as much as possible. From the MAP, appropriate action and planning to improve value-added steps and eliminate non-value added steps in the current system would be easier to do [4].

Value Stream Mapping Measures
Following are some of the time measures of VSM

Takt Time (T/T): Takt time is a time within which a product needs to be finished according to customer demand.

Cycle Time (C/T): Cycle time is the total time required to complete a process.

Lead Time (L/T): It is a total time taken by suppier to deliver the finished product customer.

Value Added Time (V/A): It is a total time requires for all value added activities in a process.

Non-Value Added Time (NV/A) It is a total time requires for all value added activities in a process.

Implementation of VSM on Small Scale Organization

Process Review and Data Collection

Initially the existing method of the processes in the industry are studied through direct observation. Hardcopy information is collected about the actual manufacturing activities, based on their Operations Manuals and the Standard Operating Procedure. The Cycle Time or the Processing Time as per the manufacturing data is calculated . All the relevant data the Production and In-process Quality Control (QC), for the month is collected and compiled it in order to establish the baseline for the data analysis. Further a line observation is conducted to monitor and to grasp the full understanding of the current practice at the production line as well as to identify the types of the wastes in the process. The Changeover time, transportation time, queuing, handling and machine time data during the monitoring period is calculated..

Following are some of the important steps, which are carried out for implementation of VSM

Work Sequence

In this step, the working time of the operators is determined and the cycle time for each operator is calculated. The deviations in workers' work are determined. In this process, it is observed that the cycle time of operations is below the takt time. For this reason, with drawing the work sequence and time towards the takt time by the method of balancing the production line, the work division among the operators is rearranged.

Takt Time Calculation

In manufacturing, takt time refers to frequency of a part or component must be produced to meet customers' demand. The formula used in the takt time calculation is the time available (per shift) divided by the demand (per shift). The average of monthly production is approx. 10000 jobs and monthly work day is 26. So that the average number of daily production is 384. The average of daily working time of the factory is 28080 seconds. Out of this time, 3120 seconds is spared for tea breaks and the remaining 24960 seconds is pure working time. The daily demand of the product by consumers is 400 for Industry under investigation.

This takes into account average productive, working time of manufacturing process. The importance of measuring takt time is due to the costs and inefficiencies factors in producing ahead of demand, which include:
• Storage and retrieval of finished goods
• Premature purchasing of raw materials
• Premature spending on wages
• The cost of missed opportunities to produce other goods
• Capital costs for excess capacity

For production line, volume demands changes slightly every month. It means the takt time is also changing. The table below showed the takt time production. Calculation refers on shifts with total of working hours per day.

Bottlenecks or constraints

In determining the presence of bottlenecks or constraints in the line, at any point where the CT is more than the takt time, the process is potential a candidate, this could cause work in progress (WIP) or extra processing time. CT in this production line is the period required to complete one of an operation, or to complete a function, job, or task from start to finish. Cycle time is used in differentiating total duration of a process from its run time. In manufacturing, cycle time is the total time it takes to produce an order.

Cycle Time (CT) = Machine Time + Man Time

Lead Time:

Lead time can be defined as total time required to manufacture an item, including order preparation time, queue time, setup time, run time, move time, inspection time, and put away time. It is the time interval between the initiation and the completion of a production process. For make-to-order products, it is the time taken from release of an order to production and shipment. For make-to-stock products, it is the time taken from the release of an order to production and receipt into finished goods inventory.

Cycle time calculation: Following tables shows cycle time calculations for different components machined in the organization

BRAKE FLANGE XXXX6				
OPERATION SEQUENCE	SHIFT	HOURS	CYCLE TIME	LOADING &UNLOADING
Lathe	80	10	6	2
Lathe	60	7.5	8	2
Cnc	200	2.5	2.4	1
Lathe	130	16.8	3.69	1
Lathe	160	20	3	1.3
VMC	110	13.75	4.36	1.3
Inspection		200	1.11	

BRAKE FLANGE NUMBER 1XXXX				
OPERTION SEQUENCE	SHIFT	HOURS	CYCLE TIME	LOADIND & UNLOADING
Lathe	80	10	2	2
Lathe	60	7.5	2	2
CNC	200	25	1	1
Lathe	130	16.25	1	1
Lathe	160	20	1.3	1.3
VMC	110	13.75	1.3	1.3
Inspection		160	1.11	

TRASMISSION MOUNT				
OPERATION SEQUENCE	SHIFT	HOURS	CYCLE TIME	LOADING & UNLOADING TIME
VMC	56	7	0.57	1.3
Milling	100	12.5	4.8	1.3
Boring	240	30	2	0.3
Milling	130	16.25	3.6	1.3
Chamfer	200	100	2.4	20
Inspection		100	0.6	

BRAKE FLANGE X1XXXX				
OPERATION SEQUENCE	**SHIFT**	**HOURS**	**CYCLE TIME**	**LOADING &UNLOADING**
Lathe	80	10	6	2
Lathe	60	7.5	8	2
CNC	200	2.5	2.4	1
Lathe	130	16.8	3.69	1
Lathe	160	20	3	1.3
VMC	110	13.75	4.36	1.3
Inspection		200	1.11	

BEARING AXEL (5XXX,XXX3)				
OPERATION SEQUENCE	SHIFT	HOURS	CYCLE TIME	LOADING & UNLOADING
Facing	40	5	12	2
VMC	48	6	20	1.3
CNC	80	7.5	6	2
Inspection		50	3.61	

Uptime Calculation

The formula of uptime is given below:
Uptime= (Available time-Total Changeover time per day)/ Available time
The available time for the company where we conducted our research is calculated below:
One 8 Hour shift= 60 min /hr*8 hrs= 480 min/shift
Machine set up Time=43 min/shift
MDI Meeting= 10 min/shift
Lunch and Prayer Time= 30 min/shift
Tea Break= 15 min/shift
Net Operating Time= 480-43-10-30-15= 382 min/shift
Number of shift= 3.
So the available time = (382*3*60) sec = 68760sec
In the bellow table we have presented all uptime we have calculated. We used these data in our current state VSM.

M/C	Available time (sec)	Average Changeover/day	Uptime
Lathe	68760	1.68	83.34
Drilling	68760	0.30	37.5
Milling	68760	1.30	75
VMC	68760	1.4	83.34
Inspection	68760	0.30	33.34

Table 1 Current State Map Calculations

	L	D	M	V	I
Effective Capacity	78	114	67	121	125
Takt Rate	0.06	0.25	0.05	0.11	0.27
Takt Time	14	4	17	9	3.6
Utilization	76.92%	21.92%	74.62%	90.90%	21.60%
Lead Time	13.2	1.5	15.17	5.33	2.17
Yield	100%	100%	100%	100%	100%
Uptime	83.34%	37.50%	83%	75%	33.34%
EPEI	6	67	6	30	67
Cycle Time	13.08	1.7	11.17	4.03	1.87
C/O Time	1.68	0.3	1.4	1.3	0.3
Available Time	20	9	20	18	8
Demand	83	135	70	120	133

The Analysis of the Current Situation

In the factory, casting comes from customer industries after coming here the casting here machining is done on casting and again send to customer industries. There are 31 workers in the production line of the yashwant. The working hours for them are from 12:00 to 12:00 & for Yashwant. All the works under the production process is labor intensive. In the workplace, there are thirteen machines in this company and production line on that the production is made. Currently, the total area of the workplace is 3400 sq ft for Yashwant Industries. The 900 sq ft part of this area is for the storage of component and the 1900 sq ft part is for production line. The machining of a various component is arranged according to lead time of the component.

Current State Situation and Map

The current situation and existing problems in the production line can be described as as follows: The Company determines the number of product to be produced on a monthly base. The number is approximately 10000. The 3product of company has taken machining on CNC to outside vendor. And also there is more wastage of time due to they give a product after one or two days. And on the production line at VMC some product has been stopped due machining of other product. This is the most important problem. For this reason, sometimes producing on time becomes a problem. While sometimes there is overproduction leading the excess to product to wait, in other days there is overtime because the product does not match up. In addition, another important thing to mention is that the Company is not able to have production breaks in order to decrease its financial expenses

and make the maintenance for the production. Fig represents the map showing the value flow of current production at yashwant. In line with the value stream map and enumerated objectives mentions above, the following changes in the production process are made in order to improve the existing conditions

Table 2 Future State Map Calculations

	L	D	M	V	V	C	I
Effective Capacity	78	135	119	66	74	200	133
Takt Rate	0.06	0.25	0.11	0.05	0.05	0.27	0.27
Takt Time	14	4	9	17	17	3.6	3.6
Utilization	76.92 %	33.75 %	13.09 %	75.75 %	67.56 %	13.50 %	20.30 %
Lead Time	14	1.65	5	12	11.5	5.56	1.15
Yield	100%	100 %	100 %	100 %	100 %	100 %	100 %
Uptime	83.34 %	37.50 %	75%	83.34 %	83.34 %	83.34 %	33.34 %
EPEI	6	90	34	6	7	44	133
Cycle Time	13	1.5	3.5	11	10.5	4.56	1
C/O Time	1	0.15	1	1	1	1	0.15
Available Time	20	9	18	20	20	12	8
Demand	83	135	120	70	70	200	133

Lead time result-

Current state lead time = 15 days

Future state lead time = 10 days

% reduction in lead time = 15%

19.4. TAKT-

Takt time = Available Time/Demand

= 4320/28
= 154 day

Takt rate = Demand/Available Time

= 64.8%/day

Min. no. of operators = Available Time*18/Demand

= 28*18*60/4320

= 7 operators

Process	Current	Future
Lathe-Driiling	30min	15min
Drilling-Milling	30min	10min
Milling-VMC 1	15	10min
Milling-VMC 2		
Lathe-CNC	1/2days	16hrs
Milling-CNC	1days	8hrs
Inspection	30min	10min

Coclusion:

Value Stream Mapping (VSM) as a key tool for execution of Lean Principles in a Small Scale Organization has been described in this paper. During the investigation current state map and future state map are drawn to visualize a perfect picture of organization. Current investigation reveals that VSM tool is very important technique to visualize the current scenario which in turns helps to remove unnecessary things from the manufacturing set up.This can help manufacturing organization to improve and regulate work environment. From current state and future map calculations corrective actions have been taken which
leads in reduction of lead time by 3 %.

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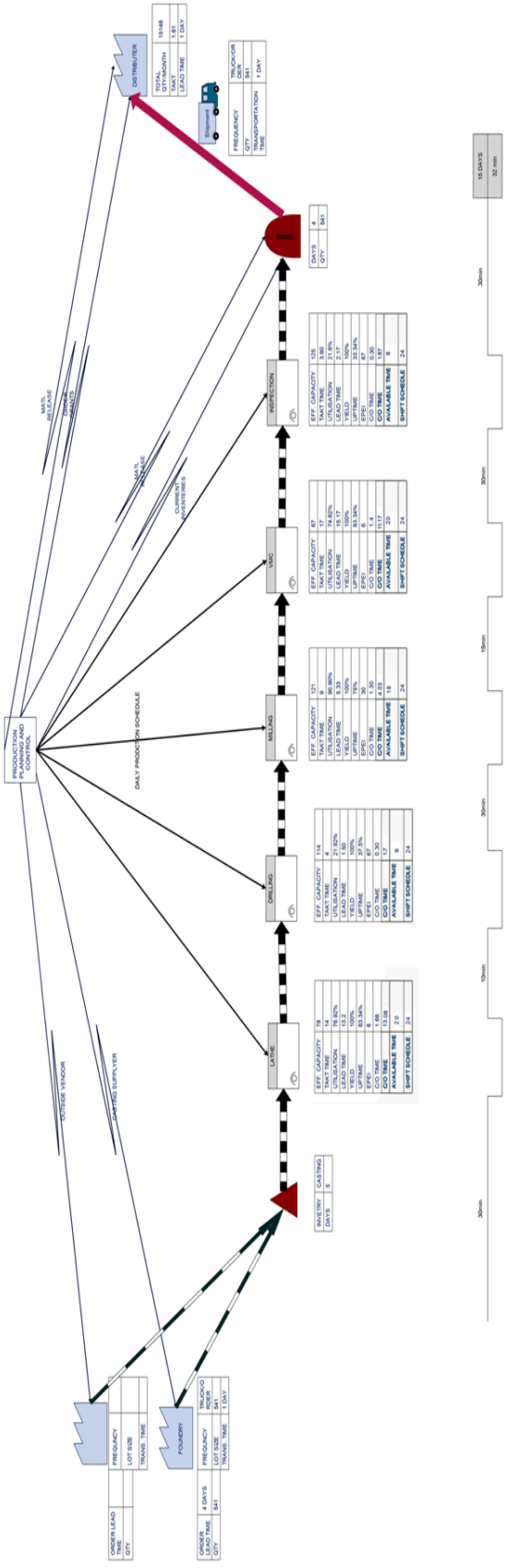

Figure 1 Curret State Map

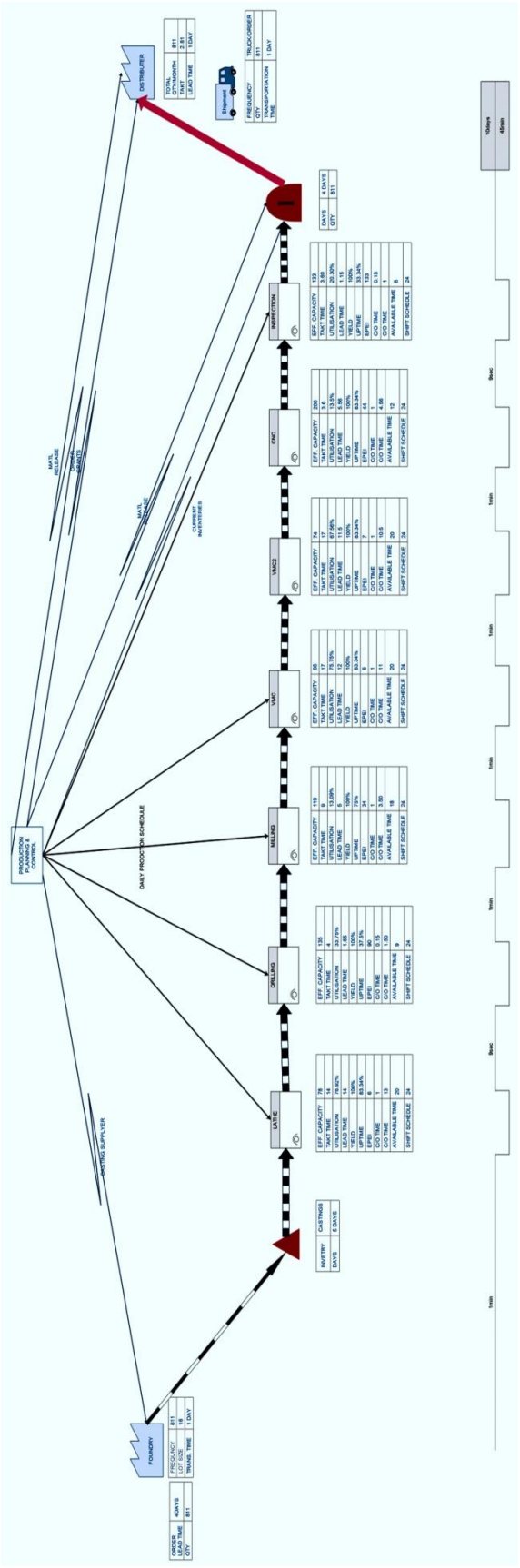

Figure 2 Future State map