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Value Stream Mapping: A Case study of Assembly Process

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Abstract

A value stream includes all activities required to transform a product from raw material into the finished goods. Value Stream Mapping scrutinizes business processes from beginning to end and a visual representation map is drawn of every process involved in the material and information flows. Then a future state map is drawn to show how things should work for best competitive advantage. Value Stream Mapping helps to identify the current flow of material and information in processes for a family of products, highlighting the opportunities for improvement that will most significantly impact the overall production system.
In this research paper we addresses method of value stream analysis, which is a tool for helping manufacturing companies to go lean and to achieve larger control of their value stream. It is a qualitative tool that is supposed to give an understanding of the value stream/value chain as a basis for reducing the pipeline of inventory and time compress the throughput time.

Keywords: *Value Stream Mapping, JIT, Lean Manufacturing.*

1. Introduction

Quality has become one of the most important competitive strategic tools, and many organizations have realized that it is key to developing products and services that support continuing success. Quality systems are designed to set a clear direction for organizations to follow enabling understanding and involvement of employees proceeding towards a common goal. There is an increasing focus on quality throughout the world. With increased competition, companies have recognized the importance of quality system. Quality management is not only to assure good quality rather than it is ensuring four main components quality planning, quality control, quality assurance and quality improvement within organizations. These four components involve management of quality continuously improving the quality of products and processes. It leads to new integrative philosophy Total Quality Management or TQM.

Total Quality Management: It is a structured system for satisfying internal and external customers and suppliers by integrating the business environment, continuous improvement, and breakthroughs with development, improvement, and maintenance cycles while changing organizational culture.

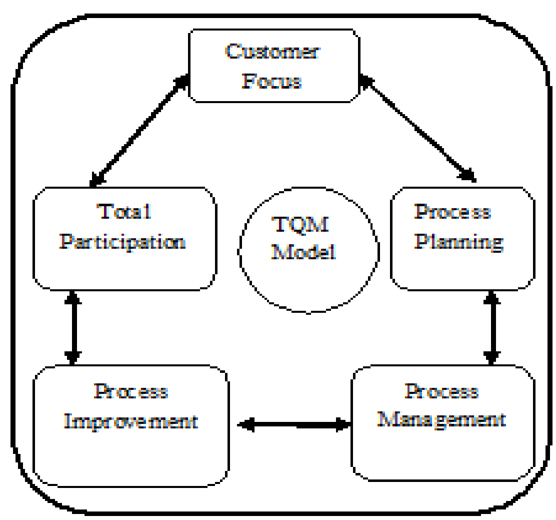

Figure: 1) Total Quality Management Model

Techniques of Total Quality Management:

1. Joint problem solving
2. Brainstorming
3. Data collection
4. Methods of analysis
5. Planning for just-in-time (JIT) management

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Lean Manufacturing:

Lean Manufacturing is an operational strategy oriented toward achieving the shortest possible cycle time by eliminating waste. It is derived from the Toyota Production System and its key thrust is to increase the value-added work by eliminating waste and reducing incidental work. The technique often decreases the time between a customer order and shipment, and it is designed to radically improve profitability, customer satisfaction, throughput time, and employee morale.

Value Stream Mapping:

A value stream is a collection of all actions value added as well as non-value added that are required to bring a product or a group of products that use the same resources through the main flows, from raw material to the arms of customers .These actions are those in the overall supply chain including both information and operation flow, which are the core of any successful lean operation. Value stream mapping is an enterprise improvement tool to assist in visualizing the entire production process, representing both material and information flow.

Value Stream Mapping symbols is shown below:

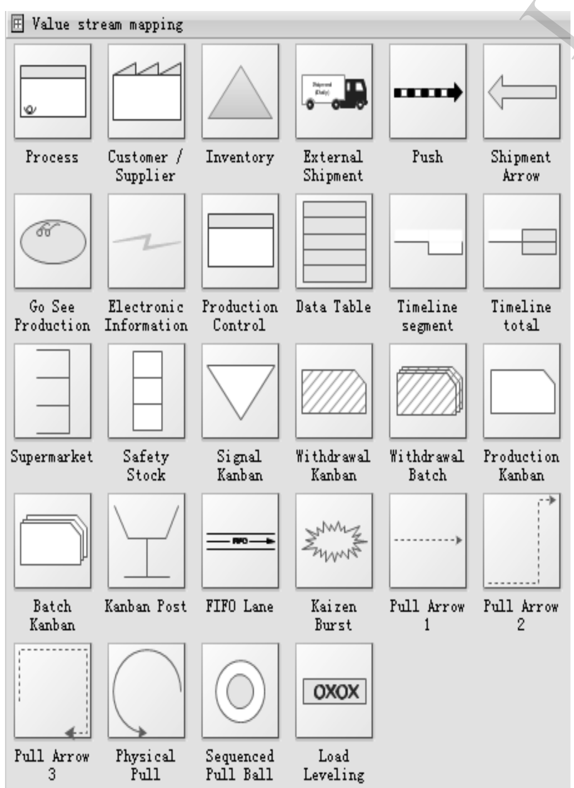

Figure: 2) Some Value Stream Mapping symbols

2. Assembly Process

The assembly line has been categorized depending upon their operations they are performing. They are namely-

1. ADDC line
2. Transmission line
3. Pre painting line
4. Paint shop
5. Post painting shop

ADDC Line: ADDC stands for Automatic Depth and Draft Control. This is used for the operation of the agriculture implements like cultivator, MB plough, disc harrow etc. ADDC system controls the depth of implement, depending upon the draft. Draft is resistance of soil which acts against the implement. ADDC is based on the principle of sensing the forces on implement hence using the hydraulic pressure to lift or lower the 3-point linkage.

Transmission Line: In this line the gear box, differential assembly, final drive assembly and ADDC coupling is done. The gear box assembly is called g1 and differential assembly is called g2. The various gear mechanisms used in tractor are:

- Sliding gear mechanism
- Synchro-mesh mechanism

Transmission assembly also consists of PTO (Power transmission output) that is used to run the pump for drawing out water and some implements like rotavator etc.

Pre Painting Line: This line includes the coupling of engine and fly feel to the transmission assembly. Then brakes clutch, steering mechanism are assembled along with the order items like weight, pressures pipe, suction pipe.

Paint Shop: This shop is basically in 2 categories one line itself and second sheet metal paint shop. On the line, the chassis of tractor is painted and is then baked in oven. In sheet metal paint shop consists of thirteen tank systems which include first cleaning of the material, re-dusting and rescaling, surface activation for better paint adhesion.

Post Painting Line:

The post painting line involves the assembly of bonnet, dashboard, electrical air cleaner, water radiator, tires etc. This also involves filling of oils like steering, air cleaner, gear box oil and diesel oil.

3. Value Stream Mapping for Assembly Process

The process analyses is carried out by collecting data from various enquiries with shop floor experts and directly participates in measuring the time involved in various processes.

1. Collecting Data:

An essential part in creating the VSMs for the process was to obtain existing data. There were a few ways in which we gained information. The first, we acquired data directly from the company. To do this we talked with the operation managers of each plant as well as the floor managers. We met with the managers and remained in contact through e-mail.

2. Time Studies:

While we received production and work instruction data from the company, as well as observed the factories in motion, we had to conduct our own time studies to get exact information on the cycle times within factory.

Time Matrix for each Process:

Process	Operators	Cycle Time (in sec)	Up time
1. ADDC Line	3	245	90%
2. Transmission Line	3	240	90%
3. Pre paint Line	3	242	90%
4. Paint Shop	5	245	98%
5. Post paint Line	4	230	94%
6. Shipping	2	240	-
Total	**20**	**1442**	**92%**

Table: 1) Time Matrix for Each Process

From the data and information retrieved from the above table and discussion from the leads of different departments, current state map with communication flow, information flow and material flow was drawn to show the process of assembly of tractor parts from the point it was ordered until delivered to the end customer. The next step is to analyses current state map and suggests lean techniques for further improvements in order to reduce lead times and increase throughput.

3. Creating Current state map-

Mapping the value stream always starts with the customer demand. To create Current Value stream map these following step are followed-

Step I- Calculate takt time: Takt time for this process is 4.83 min.

Step II- Understand Customer Demand: Customer demand is monthly or daily demand of customer as per need. Customer demand is 180 Units/ day or 90 units /shift for assembly process.

Step III- Mapping the Process Flow: This step involves various processes which are in sequence to complete product development and calculation of cycle time, changeover time and uptime for each. In this research five processes are given to complete products which are discussed earlier.

Step IV- Map the Material Flow: The flow of material from raw to finished good is given by supplier to customer.

Step V- Map Information Flow: The information flow is also incorporated to provide demand information, which is an essential parameter for determining the process in the production system. Various data regarding cycle time (c/t), changeover time (c/o), uptime, takt time etc.

Step VI- Calculate Total Product Cycle Time: After both material and information flows have been mapped, a time-line is displayed at the bottom of the map showing the processing time for each operation and the transfer delays between operations. The time-line is used to identify the value-adding steps, as well as wastes, in the current system. PLT for our process is 4.30 days.

Step VII- Detail Off-Line Activities: Activities like placing of order, supply of material, daily schedule. Monthly forecast etc is involved in this section which is well executed by transportation, supplier icons and information flow lines.

Step VIII: Identify Opportunities for Improvement: Gathering of opportunities and also to write a summary on these observations to further improve throughput rate and to draw a future state map which shows changes in process.

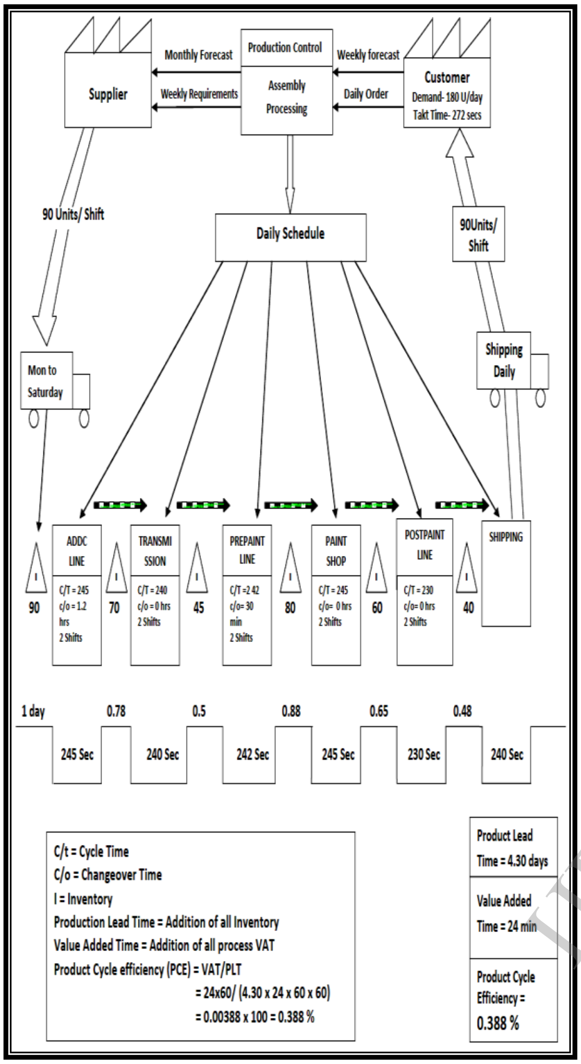

Figure: 3) Current State Value Stream map

4. Analysis of Current State Map:

The current state map is a fancy way of saying 'what happens now' or the 'as-is' process. The current state map should show all the process steps and sufficient detail on how each step is completed and what happens to the items being processed. This will enable us to spot the causes of problems and thus the means to improving the flow, efficiency, reliability and flexibility of the process. It can be as detailed or as simple as you need and can also exist in a number of different versions for consumption by different internal or external groups.

We analyzed in our CSM that PLT for assembly process is 4.30 days and value added time is 24 mints. We have found wastage during changeover of one process to another.

5. Creating Future State Map:

To create future state map these are following findings-

- Product Lead Time (PLT) - 4.30 Days
- Value added time - 24 min
- Product Cycle Efficiency (PCE) - 0.388%

Step I- Create a Cycle Time / Takt Time Graph: From the data collected and calculated during the creation of the current state VSM we are able to draw a cycle time / takt time graph. This graph simply compares the individual cycle times to the overall takt time of our process. This is an important step as it will help us make decisions as to how and what to improve in future steps.

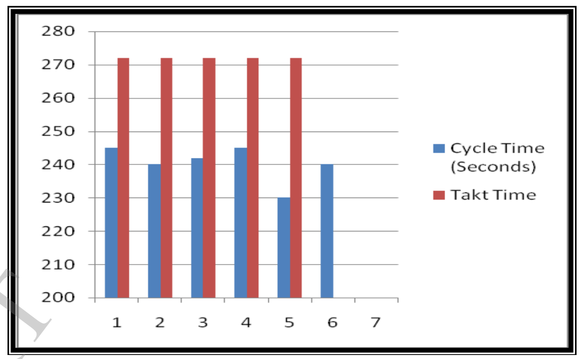

Figure: 4) Comparison of Cycle Time of Various process with Takt Time

Step II- Make to order model: Next, we must decide what type of distribution model we will develop. Will we build to a finished goods supermarket or ship directly to the customer? In our example, we only produce one product and customer demand is relatively stable. Therefore, it would make the most sense to develop a make to order model. This means we would only produce what the customer wanted, when they wanted it .We have created a make to order model for our process. We have reduced wastage during changeover of one process to another thus PLT for process get reduced.

Step III- Calculate Optimal Crew Size and Implement One Piece Flow: Optimal crew size for this process is Total Cycle Time/ Takt time i.e. 24 min/ 4.53 min. This resulted in an optimal crew size of 5.29 operators. Since we cannot have 0.29 persons they rounded up to 5.

Step IV- Pull Process: Anytime we build to supermarkets we must have a way of signaling when to produce and when not to produce. There are a variety of ways to accomplish this. The easiest way is to use Kanban.

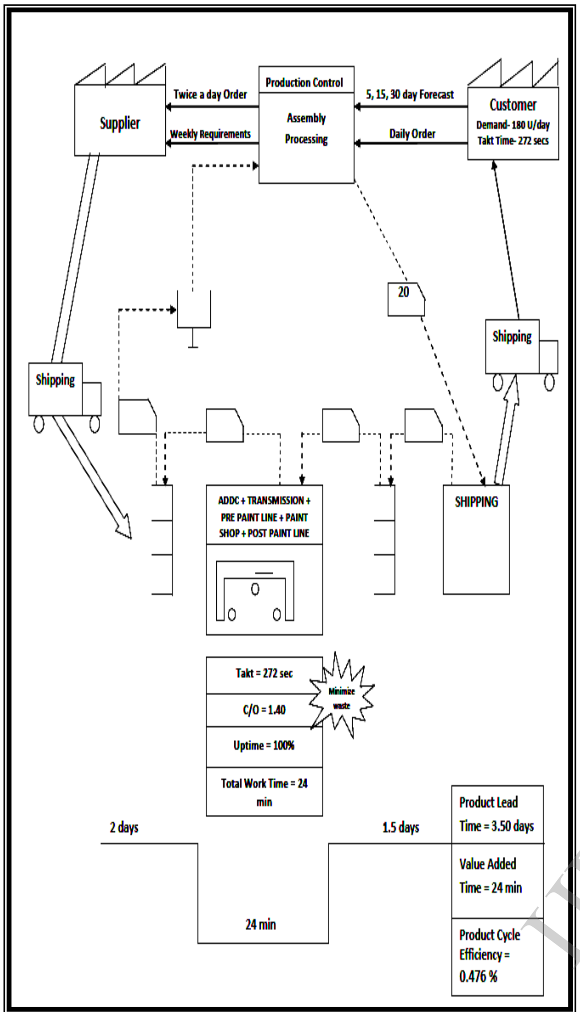

Figure: 5) Future Value Stream Map

6. Analysis of Future Stream Map:

In Future State Map for assembly process two processes are gathered to reduce non value added time during processes. Supermarkets are placed between processes to reduce inventory wastages during process and to turn process from build to stock to make to order. Make to order process lead to assembly of parts when order placed by customers. It results reduction in inventories. The information and communication flow between processing lines improved by scheduling pacemaker in the process as well process turned from push to pull by Kanban system.

On this research we have made some sizeable improvements. Production Lead-time (PLT) has gone from 4.30 days to 3.5 days, and the process cycle efficiency (PCE) has gone from 0.388% to 0.476%.

4. Result & Discussion

This research work has been intended to Value Stream Mapping (VSM), which is becoming an essential tool for realizing lean manufacturing in actual production settings. Essential concepts have been discussed, as have common symbols and nomenclature, methodologies, and curriculum infusion techniques.

The results are shown in the form of current and future process Mapping and improvement is shown in the reduction in inventory and Takt Time.

Cycle Time: It is the actual time required to complete a component at one station. Maximum work load of Bottleneck Station in a line. Cycle time describes how long it takes to complete a specific task from start to finish. This task may be to assemble a widget or answer a customer service phone call. Cycle time is always less than or equal to Takt time. Cycle time can be measured with a stop watch.

Production Lead Time or Manufacturing Lead Time: The PLT represents the total time – value added and non value added – it takes a product to make it through an entire value stream.

This is often called the "call to cash" time since it helps us understand the time between taking the order and receiving payment for the delivered goods.

Takt time: The word takt is German and literally means pace or rhythm. It is the maximum time available to complete a component at one station as per the customer requirement. In manufacturing terms takt time calculated based on customer demand. Takt time was the speed at which parts must be manufactured or assembly of a product in order to satisfy demand and it is the heart beat of any lean system**.** Takt time cannot be measured with a stop watch. It can only be calculated. To calculate takt time think touchdown, or T/D, since we simply divide the net available time by the customer demand.

Calculation for Takt Time:

Customer Requirements = 90 per shift
One shift = 8 Hours = 480 Min
We consider our production process is 85% efficient and then there is 408 min in one shift.
Now time required to assemble one Tractor = 408/90

Takt Time = 4.53 min = 272 seconds

Current Takt time of the company which is decided by customer is 272 seconds. Work station of each station should be balanced by 4.53 min.

5. Conclusion

The purpose of this study was to develop a value stream map for assembly process of tractor parts. The goal was to identify and eliminate waste which is any activity that does not add value to the final product in the assembly process. It also aimed to reducing lead time and increasing throughput rate of parts.

These following are some of the salient conclusions that drawn based on the studies:

1. It was observed from the current state map that the lead processing time for the product is 4.30 days and value added time is 24 min and PEC is 0.388%
2. The difference b/w lead time and processing time shows that there are lots of non value activities in the process flow which is in the form of waiting for part, moving parts from one to another, setting up time and inventories.
3. The finished goods before supply wait in the warehouses so market demand of customer meet reduces wastage of time during inventory storage.
4. The process turns from push to pull.
5. Process lead time reduces to 3.50 days and Product Cycle Efficiency increase to 0.476%

6. Future Work

The following research points maybe suggested for future work:

1. This research work focused on the exploration of VSM at a broad base of observation and in one industry only. Further analysis of this topic may find benefit in the more in-depth study of VSM examples, using this research as background.
2. Verification studies of the proposed VSM method are necessary to determine the efficacy of the method, and how it may be advanced.
3. In order to avoid unplanned machinery downtime, Total Productive Maintenance (TPM) techniques can me implement because it increases the efficiency and useful life of the equipment.
4. Value stream map can also draw for service sector organization in order to understand their process more clearly.

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