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VALUE STREAM MAPPING IN LEAN MANAGEMENT CONCEPT

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Abstract: *Value stream mapping is considered as tool for regularising the flow materials from end to end. Different studies are made in this area in case to case basis. Accidents, strains, fatigues, defects are the main reasons for re-analysis but to improve productivity, implementing new technologies and for modernisation also present stream and future streams are prepared. Value stream mapping generally prepared on one component or multiple components in the supply chain. One completion of the existing value stream mapping, on the basis of brainstorming sessions the future scheme mapping is developed. The time interval of doing such analysis is depending on the area such analysis is made. Many areas in the supply chain require frequent analysis because of the dynamic nature of that component in supply chain. Preparation of distribution channel requires such analysis and it is frequently analysed to check the possibilities of 3rd party logistics and 4th party logistics. This paper is prepared on the basis of the study in the area of production operations on assembly line techniques. Material flow is calculated with the time consumption in each stage. Lean manufacturing practices is a part of having lean supply chain management. This article is concentrating only one component in the supply chain i.e. production, which is a major component in the supply chain. After making the analysis of Make or Buy and the Make decision taken, then the layout design is prepared. This layout design may have to for adequate changes during operations for many reasons mentioned above along with improvement in productivity. Whereas the costing of each product is based on the total fixed cost and the individual variable cost. Analysis is a discussing about the necessities of future scheme mapping.*

Keywords: *Lean Manufacturing, Value Stream Mapping, Future Stream Mapping, Vendor Managed Inventory, Economic Order Quantity, Takt time, Cycle Time.*

INTRODUCTION

Value stream mapping is management tool used to calculate the material movements at supply chain as a whole or at any component or combination of one more components in supply chain. Materials and accessories are procured and value addition is done at every step of production and converted to semi finished goods and finish goods. Supply chain start from procurement by the vendors for the purpose of the production company and ends with the product delivery to the consumer at their site and demonstrate it. The quantity of the material flow and time taken at every step is calculated in the bigger concept of the production management known as lean management.

VALUE STREAM MAPPING

Value Stream Mapping is a method of visually mapping a product's production path of materials and information from vendor of raw materials to the door step of consumer. Value stream mapping can be classified as:-

- Procurement mapping
- Process/Production mapping
- Distribution mapping
- Information flow mapping

Procurement mapping

Production is solely depending on Material Requirement Planning or Manufacturing Resource Planning or Just in Time which is integrated by the manufacturing organisation and its suppliers. Suppliers will take make or buy decision on the basis of profitability and other criteria. If the decision is taken for procurement then suppliers manage the Vender Managed Inventory (VMI). Inventory management tools like Economic Order Quantity (EOQ) and Lead time for procurement will be used to have optimal inventory cost at Vender Managed Inventory (VMI). Calculation of EOQ will help the vender to procure quantity, total number of orders and frequency of each order. But that frequency must be higher than the actual lead time of the procurement. If the lead time is higher that the interval calculated on the basis of EOQ, then lead time must be considered as procurement time or calculating reorder level and time.

Process/ Production mapping

On receipt of raw materials and accessories, the inventory at production line may be for few hours only. The respective bays or substations accept the raw materials for process and components and accessories are directly delivered to the assembly line. Manufactured subassemblies and components are assembled in production line and move as per the layout. For example a car manufacturing may take more than two months but assembly line will deliver a car in every 2.5 minutes. It means every car which delivered in two and half minutes are started their journey almost two months before.

Distribution mapping

Finished goods are taken from finished goods inventory to transit inventories, transportation inventories and dealers stock. Movement of finished goods are mapped by choice of method of transportation and combination of vehicles opted for. Sea cargo can take more products with lesser cost but time taken for delivery will be high. Many times rail may suitable to move the products on land but surface transport is an essential transport for any combination. Many companies are opting for a combination of owned logistic services, 3rd party logistics and 4th party logistics. Selection of any combination is totally based on the time and the cost.

REVIEW OF LITERATURE

Almost all the works under value stream mapping is done on case to case basis or as case study method. Whereas the scholars gave the value to the word “value” through their studies and experiments. The critical starting point for lean thinking is value. Value is the information or product that the customer is willing to pay for and can only be defined by the ultimate customer (Womack &Jones, 1996). The value is defined by the customer and created by the producer. From the customer's standpoint, this is why the producer exists (Womack &Jones, 1996).

Value stream mapping has many benefits. Mapping will help visualize the entire production of a product at a plant level, not just single process level. It is important to be able to understand the entire flow of a product at a plant level to best understand what to fix. particular process may appear to be a problem, but when looking at the entire manufacturing process it may not be a problem at all. Value stream map will help identify the source of the real problems. Value stream maps will help show wastes and more importantly help identify the sources of waste.

Womack & Jones, (1996) The third step in lean thinking is flow. Flow is the progressive achievement of tasks along the value stream so that the product proceeds from raw material into the hands of the customer with no stoppages, scrap, or backflow .Once started, product will advance through a manufacturing plant without stopping. A product should seamlessly move forward from process to process without having to wait. Value added time to the product needs to be maximized and non-value added time minimized. In order to accomplish this, the product must continually be undergoing processing until finished. Efforts need to be directed at eliminating all impediments to continuous flow. The fourth step in lean thinking is pull. Pull is the concept of letting the customer pull the product from you as needed rather than pushing products onto the customer.

Duggan, 2002 Many producers only want to make what they are already making and the customers will often settle for what they are offered. Producers do not see what the customer or consumer really wants. When the customer no longer accepts what they are given, producers tend to use techniques such as lowering pricing or offering a variation of the same in order to entice buyers to purchase their product. The first step in lean thinking is to determine what the value is in terms of the customer.

The second step in lean thinking is to identify the value stream. Value stream comprises all of the actions, both value added and non-value added, required to bring a product from raw material into the hands of the customer.

Tapping, Leyster & Shuker, (2002) A value stream map is a tool used to chart the flow of materials and information from the raw material stage, through the factory floor, to the finished product. The purpose of the map is to help identify and eliminate waste in the process. It is a systematic approach that empowers people to plan how and when they will implement the improvements that make it easier to meet customer demand.

Value stream mapping is a visual representation of the material and information flow of a particular product family (Tapping, Leyster &Shuker, 2002). Value stream mapping consists of the creation of a current state map and a future state map. The current state map charts the present flow of information and material as a product goes through the manufacturing process. Its purpose is to help understand how a product currently flows. The future state map is a chart that suggests how to create a lean flow. The future state map uses lean manufacturing techniques to reduce or eliminate wastes and minimize non-value added activities. The future state map is used to help make decisions and plan future process improvement projects.

Yu et al. (2009), a number of inhibiting factors for applying value stream mapping to the construction industry include:

(1) An underlying prerequisite for VSM is the repetition of the production process.

(2) VSM is a quantitative tool that uses a list of process data to depict the current state of the process and to determine what the future state will be. However most of construction companies usually do not fully track the construction processes and data.

(3) Key concepts/elements used in VSM, such as inventory, cycle time, takt time and change-over time are defined in the manufacturing context and seem not applicable to construction.

RESEARCH METHODOLOGY

Case study method is adopted in this research paper. The first case is taken up only to understand the movement of material. Benz engine manufacturing (AMG) is done by single technician moving the engine to different places to get it assembled. A value stream mapping is prepared in manufacturing of shaft and bar. Analysis is made on exisiting value stream mapping and future stream mapping is prepared.

COLLECTION OF DATA

The present study is based on the observation method. Timing of the movements of materials in manufacturing and assembly line is observed by the researcher and found out the time of the material arrival at each station, value adding time and material departure time from each workstation. All movements are plotted through diagrams and diagrams are analysed with the data noted as per critical path method.

Secondary data is collected for material movement flow from different stations from the organisation manuals. Present layout designs and availability of material handling vehicles are taken from the inventory manual.

STUDY ON PROCESS MAPPING

CASE – I

Benz engine process mapping

At southern part of the Germany there is municipality known as Affalterbach located in Ludwigsburg district. AMG plants located at Affalterbach. Benz engine is build with the principle that one man one engine.

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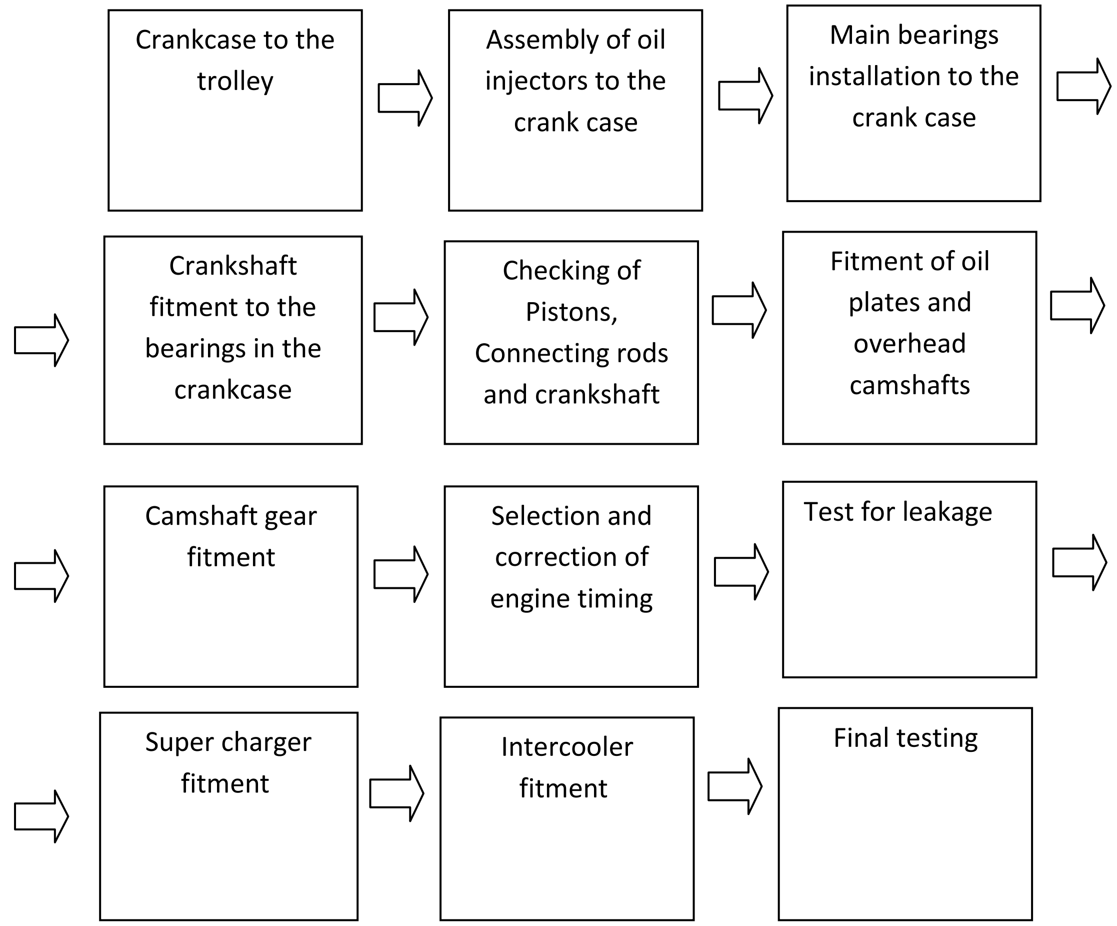

The layout is set here as the technician and product move and the machines are fixed. To have correct value scheme mapping the calculation of timing for each process is essential.

CASE II

Manufacturing of different shafts with takt time

	Process	Cycle Time	Takt Time
Shaft	Spine Rolling	26	32.25
	Grooving	35	32.25
	Bowl Induction Hardening	65	32.25
	Stem Induction Hardening	65	32.25
	Tempering	60	32.25
	Grinding	60	32.25
	Magna Flux	60	32.25
Bar	Turning	69	32.25
	Spine Rolling	26	32.25
	Grooving	35	32.25
	Boot Groove Rolling	32	32.25
	Induction Hardening	70	32.25
	Tempering	60	32.25
	Bend Checking	40	32.25
	Magna Flux	60	32.25
Assembly	Sub Assembly	58	32.25
	Assembly	80	32.25

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CURRENT VALUE STREAM MAPPING

	value added	non value added	activity takt time	activity va per item	batch size	changeover loss per item	changeovers per day	customer daily demand	cycle time	cycle time per item	defects loss per item	defects percent	inventory	lead time	oee loss per item	oee percent	takt time	time per changeover	total value added	value added percent
	sec	day	sec	sec	Item	min	co	item	sec	sec	min	%	item	day	sec	%	sec	min	min	%
SHAFT		1.33											3200.00							
Spline Rolling	3744.00		32.25		144.00	0.04	3.00		3744.00	26.00	0.00	1.00			7.74	76.00		30.00		
SHAFT		0.18											425.00							
Grooving	5040.00		32.25	35.00	144.00	0.04	1.00		5040.00	35.00	0.00	0.70			6.55	79.70		90.00		
SHAFT		0.33											800.00							
Bowl Induction Hardening	9360.00		32.25	65.00	144.00	0.05	1.00		9360.00	65.00	0.00	0.20			8.68	73.10		120.00		
SHAFT		0.00											1.00							
Stem Induction Hardening	9360.00		32.25	65.00	144.00	0.05	1.00		9360.00	65.00	0.00	0.20			8.68	73.10		120.00		
SHAFT		0.02											40.00							
Tempering	18000.00		32.25	60.00	300.00	0.00	0.00		18000.00	60.00	0.00	0.10			6.45	80.00		0.00		
SHAFT		0.25											600.00							
Grinding	8640.00		32.25	60.00	144.00	0.06	1.00		8640.00	60.00	0.00	0.40			8.68	73.10		150.00		
SHAFT		0.10											240.00							
Magna Flux	8640.00		32.25	60.00	144.00	0.01	3.00		8640.00	60.00	0.00	0.10			3.22	90.00		5.00		
BAR		1.33											3200.00							
TURNING	9936.00		32.25	69.00	144.00	0.05	1.00		9936.00	69.00	0.01	0.50			6.87	78.70		120.00		
BAR		0.19											450.00							
SPINE ROLLING	3744.00		32.25	26.00	144.00	0.04	3.00		3744.00	26.00	0.00	1.00			7.74	76.00		30.00		
BAR		0.25											600.00							
GROOVING	5040.00		32.25	35.00	144.00	0.04	1.00		5040.00	35.00	0.00	0.60			6.55	79.70		90.00		
BAR		0.35											850.00							

BOOT GROOVE ROLLING	4608.00		32.25	32.00	144.00	0.04	3.00		4608.00	32.00	0.00	0.10			6.42	80.10		30.00		
BAR		0.25											600.00							
INDUCTION HARDENING	10080.00		32.25	70.00	144.00	0.04	1.00		10080.00	70.00	0.00	0.20			8.68	73.10		90.00		
BAR		0.02											40.00							
TEMPERING	18000.00		32.25	60.00	300.00	0.02	1.00		18000.00	60.00	0.00	0.10			6.45	80.00		40.00		
BAR		0.10											250.00							
BEND CHECKING	5760.00		32.25	40.00	144.00	0.01	3.00		5760.00	40.00	0.00	0.10			3.22	90.00		10.00		
BAR		0.10											250.00							
Magna Flux	8640.00		32.25	60.00	144.00	0.01	3.00		8640.00	60.00	0.00	0.10			3.22	90.00		5.00		
BAR		0.15											350.00							
CV		1.46											3500.00							
SUB ASSEMBLY	8352.00		32.25	58.00	144.00	0.02	3.00		8352.00	58.00	0.00	0.10			3.22	90.00		15.00		
SHAFT		0.17											400.00							
Shaft		0.21											500.00							
ASSEMBLY	5120.00		32.25	80.00	64.00	0.02	3.00		5120.00	80.00	0.00	0.10			3.22	90.00		15.00		
Time Summary Shaft														8.63			32.25		2367.73	21.28
Customer								2400.00												
SUPPLIER																				
SUPPLIER																				
SUPPLIER																				
Time Summary														8.63			32.25		2367.73	21.28
Time Summary														8.63			32.25		2367.73	21.28
													16296.00							

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FUTURE VALUE STREAM MAPPING

Tag	Operation	VA	NVA	Data	Data	Data	Data	Data	Data	Data	Data	Data	Data	Data	Data	Data	Data	Data	Data	Data	Data	Data
		value added	non value added	activity takt time	activity va per item	batch size	changeover loss per item	changeovers per day	customer daily demand	cycle time	cycle time per item	defects loss per item	defects percent	inventory	lead time	max	oee loss per item	oee percent	takt time	time per changeover	total value added	value added percent
		sec	day	sec	sec	item	min	co	item	sec	sec	min	%	item	day	item	sec	%	sec	hr	min	%
A030	Super marlet															0.00						
A040	Type		0.01											33.00								
A050	Grinding	10080.00		32.25	70.00	144.00	0.06	1.00		10080.00	70.00	0.00	0.40				8.68	73.10		2.50		
A060	Spline Rolling	3744.00		32.25		144.00	0.04	3.00		3744.00	26.00	0.00	1.00				7.74	76.00		0.50		
A070	TRIPOT		0.18											425.00								
A080	Grooving	5040.00		32.25	35.00	144.00	0.04	1.00		5040.00	35.00	0.00	0.70				6.55	79.70		1.50		
A090	TRIPOT		0.33											800.00								
A100	Bowl Induction Hardening	9360.00		32.25	65.00	144.00	0.05	1.00		9360.00	65.00	0.00	0.20					73.10		2.00		
A110	TRIPOT		0.00											1.00								
A120	Stem Induction Hardening	9360.00		32.25	65.00	144.00	0.05	1.00		9360.00	65.00	0.00	0.20				8.68	73.10		2.00		
A130	TRIPOT		0.02											40.00								
A180	Magna Flux	8640.00		32.25	60.00	144.00	0.01	3.00		8640.00	60.00	0.00	0.10				3.22	90.00		0.08		
A240	TURNING	9936.00		32.25	69.00	144.00	0.05	1.00		9936.00	69.00	0.01	0.50				6.87	78.70		2.00		
A250	AXLE BAR		0.19											450.00								
A260	SPINE ROLLING	3744.00		32.25	26.00	144.00	0.04	3.00		3744.00	26.00	0.00	1.00				7.74	76.00		0.50		
A270	AXLE BAR		0.25											600.00								

A280	GROOVING	5040.00		32.25	35.00	144.00	0.04	1.00		5040.00	35.00	0.00	0.60				6.55	79.70		1.50		
A290	AXLE BAR		0.35											850.00								
A300	BOOT GROOVE ROLLING	4608.00		32.25	32.00	144.00	0.04	3.00		4608.00	32.00	0.00	0.10				6.42	80.10		0.50		
A310	AXLE BAR		0.25											600.00								
A320	INDUCTION HARDNING	10080.00		32.25	70.00	144.00	0.04	1.00		10080.00	70.00	0.00	0.20				8.68	73.10		1.50		
A330	AXLE BAR		0.02											40.00								
A340	TEMPERING	27000.00		32.25	90.00	300.00	0.00	0.00		27000.00	90.00	0.02	1.00				6.45	80.00		0.00		
A350	AXLE BAR		0.10											250.00								
A360	BEND CHECKING	5760.00		32.25	40.00	144.00	0.01	3.00		5760.00	40.00	0.00	0.10				3.22	90.00		0.17		
A370	AXLE BAR		0.10											250.00								
A380	Magna Flux	8640.00		32.25	60.00	144.00	0.01	3.00		8640.00	60.00	0.00	0.10				3.22	90.00		0.08		
A390	AXLE BAR		0.15											350.00								
A400	CV		0.04											100.00								
A420	SUB ASSEMBLY	8352.00		32.25	58.00	144.00	0.02	3.00		8352.00	58.00	0.00	0.10				3.22	90.00		0.25		
A590	TRIPOT		0.17											400.00								
A610	Half Shaft		0.00											1.00								
A620	ASSEMBLY	5120.00		32.25	80.00	64.00	0.02	3.00		5120.00	80.00	0.00	0.10				3.22	90.00		0.25		
Z010	Time Summary Tripot														3.90				32.25		2241.73	44.56
Z020	Customer								2400													
Z030	SUPPLIER																					
Z040	SUPPLIER																					
Z390	SUPPLIER																					
Z420	Time Summary Axle														3.90				32.25		2241.73	44.56
Z430	Time Summary														3.90				32.25		2241.73	44.56
			2.16											5190.00								

Overhaul equipment effectiveness loss can be calculated by loss percentage in sec=takt time *(100-oee)

The time loss due to OEE is 105,59 sec.

Defect loss can be calculated by Defect Loss Per Item=Cycle Time*(100/(100-defect percentage))-1

Spine Rolling and Grooving has maximum loss of 0.26 and 0.25.By improving the quality procedures defects can reduced and company can move towards the zero defects. In the second figure turning and spine rolling has maximum defects of 0.35 and 0.26.

In the current state value added percentage is 21.28% and non value added percentage is 78.72% and hence waste is more.

MAJOR FINDING AND SUGGESTIONS

As per the current state the lead time is 8.63 days and value added percentage is 21.28. non value added percentage is 78.72 and in days it is 6.76. Advantages of adopting feature stream mapping are presented in a table below:-

PARAMETER	CURRENT STATE	FUTURE STATE	PERCENTAGE	RESULT/ ADVANTAGES
LEAD TIME(DAYS)	8.63	3.9	54.81	DECREASES
Lead Time(hours)	185.55	83.85	54.81	DECREASES
VALUE ADDED PERCENTAGE	21.28	44.56	109.40	INCREASES
NON VALUE ADDED PERCENTAGE	78.72	55.44	29.57	DECREASES
NON VALUE ADDED ACTIVITY(DAYS)	6.76	2.16	68.05	DECREASES

In future state all the waste should be identified and proper action will be taken which will increase the value added percentage to 44.56%.

In the future vsm value added percentage is 44.56% while non value added percentage is 55.44% as shown.

CONCLUSION

Value stream mapping is considered as one tool in Lean manufacturing process. It is aimed to calculate the time loss, defects percentage and to understand overhaul equipment effectiveness. After making the analysis a future scheme mapping should be prepared to remove the defects of existing value scheme. This process may be done first on any assembly layout and should be repeated after adopting any new technology or any modifications on the layout or change in production.

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