Productivity Improvement of 380 C. A. of Clutch plate using VSM

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Abstract - With the globalization, Toyota Production system has emerged as one of the tools for reducing non value added activities and move towards continuous improvement. Value Stream Mapping has been used for mapping the existing situation of the 380 clutch assembly line and after discussion, trial run future state has been mapped to increase value added ratio. For this pull production system has been beneficial for making 380 C A line as a model line. With the help of supermarket work in process inventory was able to track and control. This Research paper deals with the implementation of Supermarket for smooth feeding arrangement as a part of productivity improvement.

Keywords: Toyota Production System, Value Stream Mapping, Value added ratio, Pull Production system, Supermarket.

I. INTRODUCTION

In the fiscal year 2015-16 it was decided to revamp the whole production system in a systematic manner. As a part of it 380 Cover Assembly Line was made a "model line" in terms of productivity, quality, cost, time, delivery, moral. While implementing model line we came through a hurdle which was timely feeding of material at the assembly line. Work in process inventory was also a big hurdle for the model line. So to address these issues a proposal of pull production system was made in the form of Supermarket. Based upon the pull created by the assembly line material will be fed to assembly line from Supermarket on JIT basis which will assist in increasing the VAR ratio of the line through inventory control.

A manufacturing supermarket (or market location) is, for a factory process, what a retail supermarket is for the customer. The customers draw products from the 'shelves' as needed and this can be detected by the supplier who then initiates a replenishment of that item. It was the observation that this 'way of working' could be transferred from retail to manufacturing that is one of the cornerstones of the Toyota Production System (TPS).

Motivation

- No adherence to pull system: - All the Assembly lines operating are production based system. It was the typical push production system; the information flowed from upstream (planner) to downstream (customer).

Figure 1.1 380 Cover Assembly line

- No tracking of inventory in the existing system: - PPC engineer is clueless about the work in process inventory from Press Shop, Machine Shop, Heat Treatment Shop, and Casting Shed.
- No use of standard bins based on capacity required per shift:-Quantity required per shift are not used for ease in inventory control. So material feeder/operator often goes to the regional stores when there is no required material at the workstation which is time consuming because of the feeder's inefficiency to provide the material at the required time.
- Identification of material is not proper:-Due to this mixing of material takes place which results in loss of productive time.
- No contingency system for sustaining the stocks: - There is no buffer stock ready for the assembly line resulting in line stoppages in a frequent manner.
- No defined area for storing the materials which is ready for assembly:-No space has been given for it.
- Wastage in the floor area: - Not properly utilizing the floor space provided for the line. WIP was getting dumped on the assembly line.
- Materials getting mixed & searching time high.
- Difficulty in identifying 'Ok'& 'Not Ok' parts.
- Excess material feeding on line:-Feeding quantity is not defined as per the requirement so there is excess of material.

Due to above reasons it was imperative to have a proper feeding arrangement system.

Problem Definition& Objectives:

"Required material not delivered at required time to 380 Cover Assembly line"

I. Process Improvement for Assembly line through JIT/KANBAN system to reduce inventory and making "380 Cover Assembly line" as a model assembly line.

II. To establish a pull production system

IV. Bought out Parts & Inhouse parts will be fed to 380 model Assembly line through Supermarket delivery system.

V. Supermarket will consist of single shift inventory prior to the next shift.

Delimitation

The first delimitation is that the collected data is only conducted in particular Assembly line. The result of the project are generated from the particular assembly line in Setco Automotive, it doesn't have precise compatibility to other companies. It might be able to provide some practical experiment for the field of pull production system.

Limited time scope (August 2015 to January 2016) was available for the project which was undertaken by the author in partial fulfillment of requirements for the master degree in "Project Management" at VJTI, Mumbai.

II. SYSTEM MODEL

Following is the Project Management Approach which will be followed in this project:-

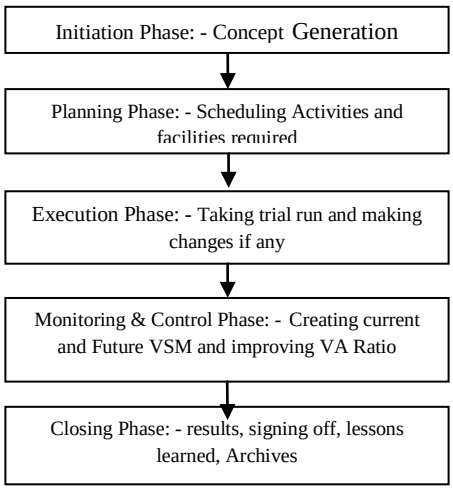

Figure 2.1 Project Management Approach

III. PREVIOUS WORK

(Vijay & kale, 2015) This research paper is based on the research work carried out at MFN-1 (Manufacturing Nozzles) Shop Floor at Bosch Ltd. Nashik. This paper highlights the Lean Practices implemented for minimizing manual intervention, reducing Lead Time and also the OEE (Overall Equipment effectiveness) improvement. The research work dealt with concept of KANBAN and Pull System to standardize the process and optimize recourse utilization and material availability. (Varsha Karandikar, 2014)In this paper best line feeding systems were implemented to support assembly line production systems to reduce the downtime at assembly line due to material shortage. (Md. Enamul Kabir, 2013)The objectives of this paper are to study and evaluate processes of the case organization, to find out current sigma level and finally to improve existing sigma level through productivity improvement. According to the objectives, current sigma level has been calculated and given suggestions for improvement. This has been done by using six-sigma DMAIC cycle. (Rosnah & Othman, 2012) The main target is to plan and test several strategies to eliminate waste on the shop floor & application of value stream mapping analysis. (C. L. Alves1, Tommelein, & Ballard, 2005)This paper investigates the use of Value Stream Mapping (VSM) for make-to-order products in a job shop environment, specifically the fabrication of Heating Ventilating and Air Conditioning (HVAC) sheet metal ductwork. Use supermarkets to control production where continuous flow does not extend upstream. (Saraswat, Kumar, & Sain, 2015)In this paper Value Stream Mapping (VSM) tool is used in bearing manufacturing industry by focusing both on processes and their cycle times for a product UC- 208 INNER which is used in plumber block. Supermarket is used for storage of WIP in future for storage of WIP; this reduces the excessive WIP at annealing.

IV. PROPOSED METHODOLOGY

Initiation Phase:-Manufacturing Engineering (M E) Department in the Company looks after process improvement in the company.

Issues faced by the Assembly department:-

1. Line stoppages were frequent

2. Batch Production system

3. Push production system

It was M E dept.'s decision to make a single piece flow for the Assembly line

This single piece flow could be achieved by making one assembly line as “model line". And replicate this to other lines. There are 5 different assembly lines according to the diameters operating on the shop floor they are as follows:

1. 330 dia, 2. 352 dia, 3. 380 dia, 4. 400 dia, 5. 430 dia

So we have selected 380 dia Cover Assembly line to be made as Model Line. Since, it is the most manufactured clutch by the company and also used in the Indian Market.

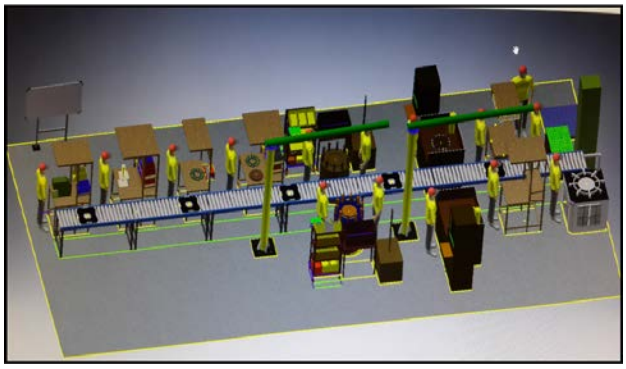

Figure 4.1 380 model line

Following are the workstations:-

1. Needle Bearing in Eye Bolt, 2. Lever subassembly,

3. Retractor spring, 4. Pressure Plate Fitment, 5. C A balancing, 6.Compressive testing machine, 7.Cleaning & inspection, 8. Strapping Machine 9. Packing

Planning Phase:-While implementing model line there was need of timely feeding of material at the Assembly line.

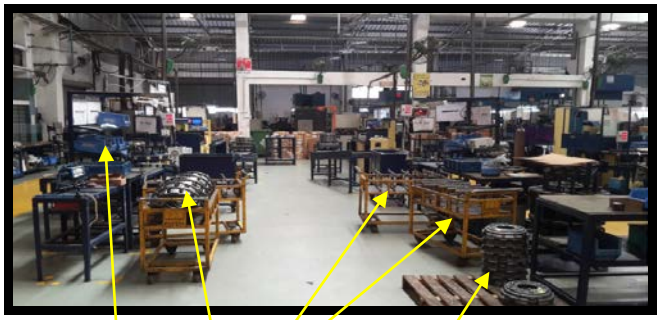

Figure 4.2 Old setup 380 C.A two lines

Housekeeping was poor & not well maintained

Unorganized way of working

Un-even work distribution among the workers

In process inventory was high (15-20 CA)

Material Storage & feeding was not proper in terms of frequency, quantity & quality.

So then there it was decided to go for Supermarket.

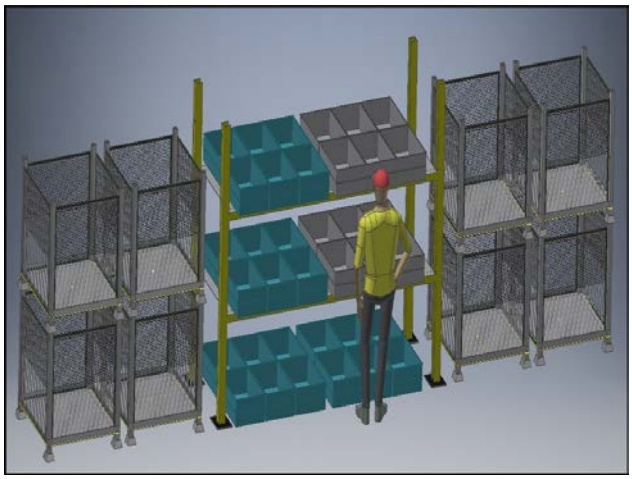

Figure 4.3 Supermarket 3D

It will consist of single shift inventory of quality approved parts which will be fed through material handlers. Also a record of inventory will be updated time to time on the board in the Assembly shop. This will help PPC department to procure only required quantity of material from other departments.

Layout:-

2D layout of the existing flow of material was prepared for material movement.

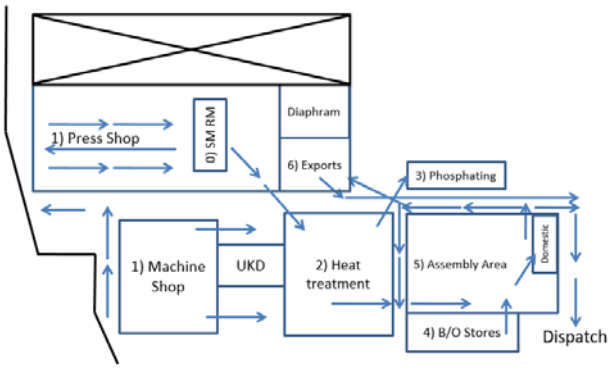

Figure 4.4 Existing layout of material flow

In this figure we can see that material is flowing from following shops:-

1. Press shop---- Heat treatment----Phospating---Assembly Shop---Domestic/Dispatch/Export

2. Machine Shop---Heat Treatment---Assembly Shop---Domestic/Dispatch/Export.

In short material movement is very high.

To reduce it new layout was prepared as below:-

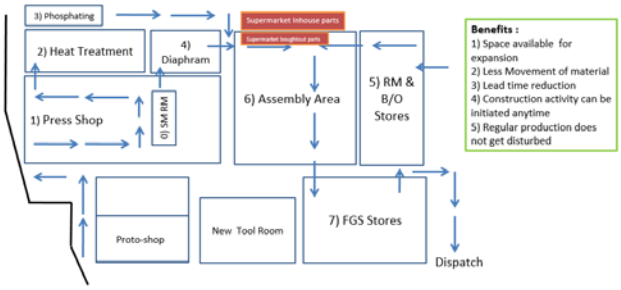

Figure 4.5 Future Layout with Supermarket benefits.

In this figure we can see that space has been identified for supermarket Inhouse and bought parts. Also it was decided to have new departmental stores in each shop that would assist Supermarket. Since every department is dumping materials in Heat Treatment shop. As a result there is high inventory being developed.

Space identification for Inhouse and bought out parts:-

The setting up of the Supermarket and the necessary arrangements requires specific location on the production floor where it can be implemented. The area allocated to us is around as shown in figure:-

Figure 4.6 Space requirement for Bought out parts (14.2 * 2.07m)

Figure 4.7 Space requirement for Inhouse parts (14.2 * 1.6m)

Segregation of Components in 380 C A line: - Identified Bought out Parts and Inhouse Parts of 380 dia Cover Assembly line.

Data Collection:

Taking trial run of bins.

Different materials were put in bin to find out its full capacity. For that 600*400 size bin was used.

Figure 4.8 Bin

In this size one shift inventory could be kept at a single time. Also it was decided to keep count free +quality approved material. Color coding was given to bins. Blue color for ok parts and if there is any rejection while assembling the clutch then rejected parts in red color bin. In this way proper identification of parts is done.

Figure 4.9 Red Bin for rejected parts.

Rack for Supermarket:

Figure 4.10 Rack for Supermarket

Rack was already available in the company, Press shop had given to PPC department for supermarket implementation. On that rack a total of 14 bins of size 600*400 could be placed.7 bins on upper side and 7 bins on the lower side.

**This photo was taken at the initial stage at that time 7 bins on the upper side were yet to be placed.*

Facilities Required:

1. 18 blue bins (600 X 400 X 200)
2. 4 MS bins (900 X 900)
3. A Rack

4. Stickers for the bins
5. Tracking Board
6. Manpower (No. 2)

V. SIMULATION/EXPERIMENTAL RESULTS

VALUE STREAM MAPPING

It is a lean tool which is used to improve value added ratio. It maps the current situation with the help of cycle time, lead time and inventory.

By making some changes future state VSM is prepared.

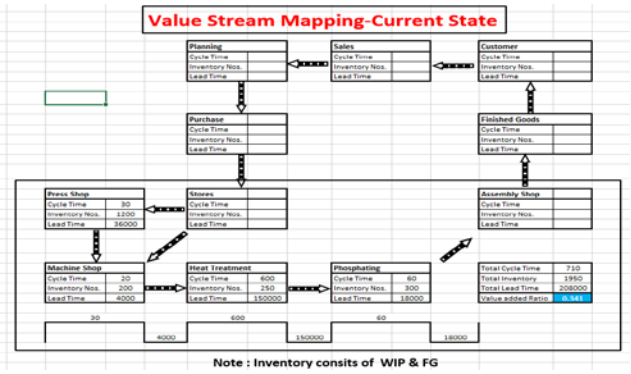

Figure 5.1 Current state VSM

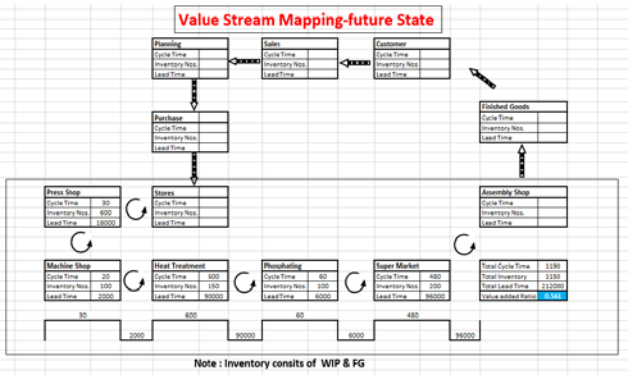

Figure 5.2 Future state VSM

In-house Parts for 380 Cover Assembly					
Part No	Part Name	Qty/Assly	Storage	Size	Qty/Storage
107	C060-0107 Release Lever	3	Blue bin	600 X 400 X 200	210
463	C006-0463 Retractor Spring (F.M.)	3	Blue bin	600 X 400 X 200	300
29	C065-0029 Eye Bolt Pin	3	Blue bin	600 X 400 X 200	1500
37	C073-0037 Adjusting Nut	3	Blue bin	600 X 400 X 200	1500
23	C073-0023 Lock Nut	3	Blue bin	600 X 400 X 200	2900
22	C071-0022 Pressure Plate Pin	3	Blue bin	600 X 400 X 200	1200
59	X072-0059 Retaining Ring(circlip)	3	Blue bin	600 X 400 X 200	2500
1212	C023-L1212 Collector Ring	1	Blue bin	600 X 400 X 200	160
11	C010-0011 Washer	3	Blue bin	600 X 400 X 200	2000
28	C074-0028 Eye bolt	3	Blue bin	600 X 400 X 200	1000

In-house Parts for 380 Driven Plate					
Part No	Part Name	Qty/Assly	Storage	Size	Qty/Storage
4821	C019-L4821 Driven Plate	1	MS Bins	900 X 900 X 700	520
4874	C022-L4874 Disc Ring	1	Bins	900 X 900 X 700	1500
1076	C129-L1076 Cushion Segment	6	Blue Bin	600 X 400 X 200	3000
2688	C016-L2688 Hub	1	Bins	900 X 900 X 700	1500
59	C021-0059 Retainer Plate	2	Bins	900 X 900 X 700	1760

Figure 5.3 Storage Details

Feeding Frequency

Part Name	CA Capacity/Bin	no of bins /Shift	Qty/Shift	Feeding freq./ day
C060-0107 Release Lever	70	3	210	3
C006-0463 Retractor Spring (F.M.)	100	2	200	3
C065-0029 Eye Bolt Pin	500	1	500	1
C073-0037 Adjusting Nut	500	1	500	1
C073-0023 Lock Nut	967	1	967	1
C071-0022 Pressure Plate Pin	400	1	400	1
X072-0059 Retaining Ring(circlip)	833	1	833	1
C023-L1212 Collector Ring	160	2	320	2
C010 0011 Washer	667	1	667	1
C074-0028 Eye bolt	333	1	333	2
	total	14		

Figure 5.4 Feeding Frequency

Note:-It is assumed that 200 cover assemblies are made per shift.

Supermarket Tracking Sheet:

380 CA									
Part Name	Part no.	Qty./bin	Incoming Quantities		Outgoing Quantities				Next shift Opening stock
			1	2	1	2	3	4	
Release Lever	107	210							
Retractor Spring (F.M.)	463	300							
Eye Bolt Pin	29	1500							
Adjusting Nut	37	1500							
Lock Nut	23	2900							
Pressure Plate Pin	22	1200							
Retaining Ring	59	1200							
Collector Ring	1212	160							
Washer	11	2000							
Eye bolt	28	1000							
Driven Plate	4821	520							
Disc Ring	4874	1500							
Cushion Segment	1076	3000							
Hub	2688	1500							
Retainer Plate	59	1760							

Figure 5.5 Feeding Frequency

IMPROVED PHASE (CONVEYOR SYSTEM):-

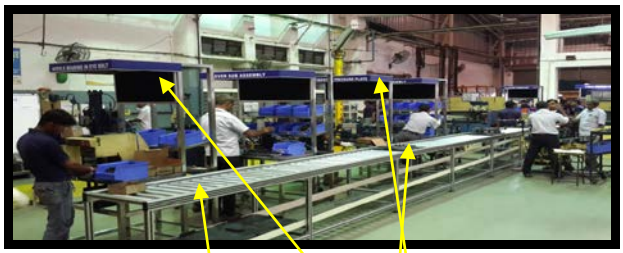

Figure 5.6 Conveyor system

1. 5S of the assembly line well maintained
2. Organized way of working by providing standard workstations & Conveyor
3. In process inventory between the process is almost 1-2 Cover Assembly
4. Single conveyor Straight line concept

5. Systematic Visual Identification of all the operations is clearly visible at a glance

6. Greater care is taken on improving the ergonomics by keeping standard working height & material stacking height, also manipulators are provided for material handling

Figure 5.7 See through lines

Figure 5.8 Standard Workstations

	Output/shift (Nos.)	Manpower(Nos)	Productivity(Nos/man)
Older Setup	190	23	8.26
Improved Phase 1	190	15	12.66
Improved Phase 2	250	15	16.66

Table 5.9 Comparison Sheet

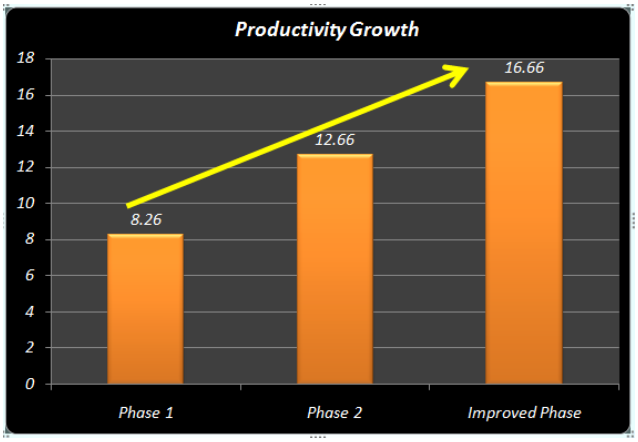

Figure 5.13 Productivity growth.

VI. CONCLUSION

Anticipated Benefits

1. Stocking will be triggered by the actual demand.

2. Tracking of inventory for the next shift making it easier to update it in the SAP

3. Aid in planning (PPC), taking into account of the existing inventory in Supermarket

4. Stoppage of line due to material shortage will be reduced to maximum extent

5. Supervisors will be more focused on production rather than material supply to the line

6. Reduction of inventory in the assembly line

7. Productivity will increase

8. Shortage of critical parts will be highlighted

9. Checking Fire fighting at the 11th hour

10. Adherence to SAP entry

11. Creating a pull for the back operations of Heat Treatment & Press Shop

12. Any last minute searching of the parts would be eliminated & Highlighting Red tag & non-moving

inventory. With the shortened production lead time through the supermarket process which would operate consistently to pitch time, and follow the tracking sheet. The over production could be reduced. The company can also reduce the amount of raw material it holds to average one week according to delivery time. The lead time will be shortened in the future. With the pull based supermarket, and continuous flow, the flows could be connected without interruption and scheduled in one point in one pace. This correct production signal ensures the whole flow operate the correct products in the right pace.

VII. FUTURE SCOPES

Kanban Card

The Kanban cards are suggested to be used, the details of how the kanban circulate in the loops are needed to be defined, and it determines how the signal flows.

Departmental Stores

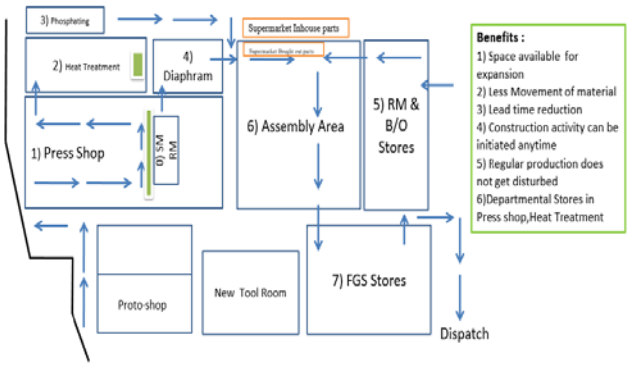

Figure 7.1 Future layout with Departmental Stores

For effective sustenance of supermarket we are planning to make departmental stores for work in process inventory which is shown by block of green color in figure. Through which material will be transferred depending upon the pull which in turn will improve the wastages of over production, inventory & transportation.

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