Implementation of Kanban based Pull Production in Finish Match Grinding Lines

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***Abstract* - In most of the manufacturing industries, uncertainties have led to higher inventories, high production lead time and increased costs associated with that due to fluctuations in customer requirements. So, this made many organizations to adopt lean manufacturing concepts and principles to improve their processes. This paper deals with implementation of kanban based pull production in finish match grinding lines. The main objective of this paper is to reduce production lead time, reduce inventory, increase customer fulfillment and to establish First in First out between two processes. Value stream mapping was done to identify the opportunities for various lean techniques. The lean principle pull was implemented for finish match grinding loop. Pull system means producing the parts or components only what the customer requires. For this, consumption control is a production control method to implement pull system. The consumption control is implemented using Kanban. The Kanban is a Japanese word which stands for "card signal" which is used for production, stock control etc. In the process of fulfilling the objectives of the work, steps were taken to reduce the production lead time, inventory, maintaining minimum buffer in the finished goods supermarket and minimizing the work in process through various methodologies, which intern resulted in improving the customer fulfillment.**

Keywords - Lean manufacturing, Pull system, Value stream mapping, Kanban, Consumption control

I. INTRODUCTION

Traditional manufacturing strategy is driven by 'Push system' with aimed to have huge inventory of product for customer's needs. Planning schedule that used as production authorization mechanism has push material from one location to other location. However, this created big problem for people on the floor in dealing with huge WIP inventories, unsynchronized production processes and producing non-required products. As a result, established companies like Toyota Motor Corporation moved to the next level of manufacturing strategy by adopting the Kanban system. The adoption of Kanban system has improved their efficiency and flexibility of manufacturing according to customer needs. The Kanban system is a pull system approach that gives authorization to produce at a required rate and specific time in order to replenish part that already consumed by the customer. As one of the lean manufacturing principles, Kanban system emphasized minimum level of inventory by producing only what is needed. It ensures the supply of the right product, at the right time, in the right quantity and at the right place [1]. The Japanese Kanban process involves more than fine tuning production and supplier scheduling systems, where supplying these when needed in production and work in progress in closely monitored minimizes inventories. It also encourages; Industrial re-engineering, such as a 'batch production' system, and, Japanese human resources management, where team members are responsible for specific work elements and employees are encouraged to effectively participate in continuously improving Kanban processes within the Kaizen concept [2]. Lean manufacturing is an applied methodology of scientific, objective techniques that causes work tasks in a process to be performed with a minimum of non-value adding activities [3]. Value Stream Mapping (VSM) technique, developed within the lean production paradigm, and was presented as an innovative graphic technique to help practitioners redesign production systems [4]. The Kanban system, being a pull system has the unique aspect of being an information network that flows backward from the external customer, through the manufacturing systems and ultimately to the company's suppliers. The system is simple to implement and use. It may consist of rectangular cards (kanbans) that are attached to specifically designed containers [5].

II. METHODOLOGY

1. Choosing product or product family- For the integrated work cells it would be creditable to implement the lean manufacturing concept which is devoted for the production of products or product family.
2. Studying the process flow – The current situation process flow will help in knowing the bottleneck and pace making process, which were identified.
3. ABC analysis – The ABC analysis was done for the products for which kanban has to be moved along with the products
4. Value stream mapping – The value stream mapping was done to identify the wastes and to find the current lead time of the products
5. Value stream design- The value stream design was used as an initial step for the conception of lean production with a goal to develop a lean production system

6. Pull implementation – After setting up a vision to achieve by VSD, the pull has to be implemented using kanban for the Finish Match Grinding loop in the Lines. The loop in the line is a self-controlled loop.

The current FMG line manufactures Element which is an assembly of barrel and plunger. This FMG Lines consists of three stages. The first stage is the manufacturing of barrel.
The second stage is the manufacturing of plunger. The third stage is the assembly of barrel and plunger which is called as Element.

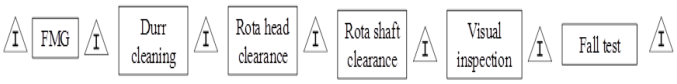


Figure 1: Element process flow

OBJECTIVES

1. To reduce production lead time.
2. To reduce inventory.
3. To increase customer fulfilment.
4. To establish First in First out (FIFO) between processes.

III. DATA COLLECTION AND ANALYSIS

The ABC analysis carried out played a major role in implementing the pull system for "A" type of Elements.
The total ABC Part numbers identified in the Elements is 349 parts, in which
A - Class parts numbers were 47
B - Class parts numbers were 96
C – Class parts numbers were 206

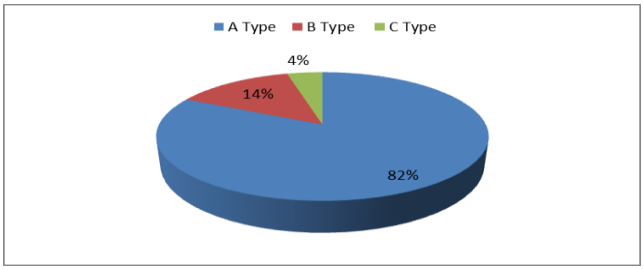


Figure 2: ABC Analysis

The selected lines part numbers are the major contributors of the A type of Elements. There are 6 part numbers for the lines.

Table1: Part numbers identified for pull

Part No.	%	Cumm %	Class	Daily Req.	Cost /unit	Total cost
382	9.25	9.25	A	1400	1171	1639400
609	7.46	16.71	A	1200	850	1020000
565	5.4	22.11	A	1000	818	818000
526	4.7	26.81	A	900	770	693000
417	3.86	30.67	A	2400	751	1802400
675	3.7	34.37	A	2100	649	1362900

A. Value Stream mapping

By constructing the value stream mapping the current metrics for the push system was identified.

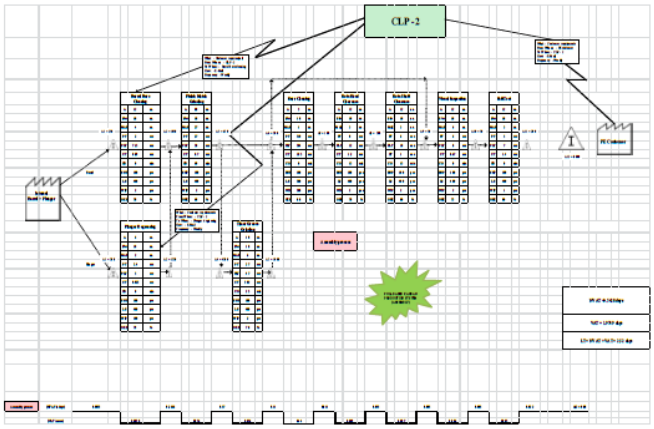


Figure 3: Schematic representation of current state VSM

From the current state value stream mapping the lead time for Line 1 was 1.32 days and Line 2 was 1.2 days. So the total lead time for both the lines was 2.52 days.

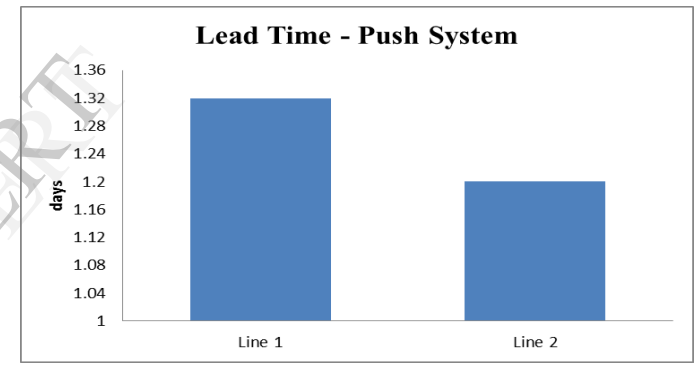


Figure 4: Lead Time of FMG Lines

The inventory data for Line 1 and Line 2 was collected in the value stream. The inventory for Line 1 was 11880 pieces and Line 2 was 10800 pieces.

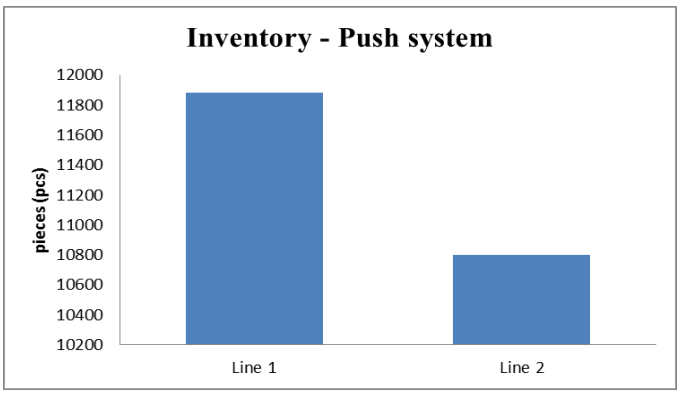


Figure 5: Inventory of FMG Lines

B. Value Stream Design

After mapping the current situation of the lines, it is proposed to improve the present conditions to achieve an optimal state, by reducing manufacturing lead time and bottleneck in the line with the help of lean principles. Part of this process involves identifying the lean tools such as cell design, finish goods super market and improvement methods such as 5S and quick change over ensuring to meet quality and delivery requirement to customers. Before starting the value stream design, a brain storming is done with planners to understand the hidden waste existing in the line.

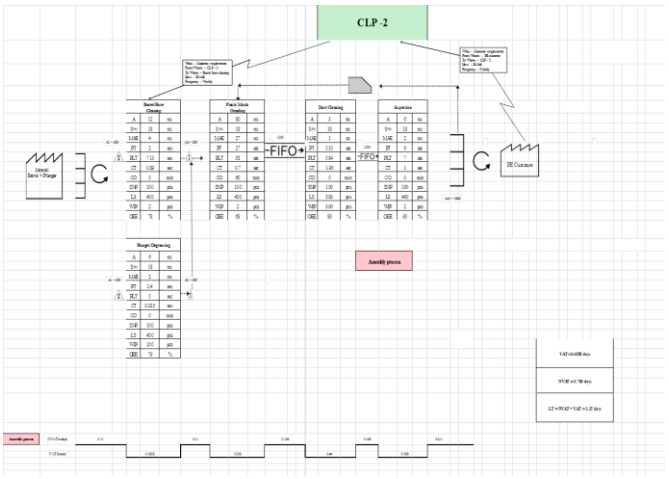


Figure 6: Schematic representation of VSD

C. First In First Out (FIFO)

The FIFO calculation was done to match the delivery takt of FMG process and Inspection. The Delivery takt of FMG was found to be 20 sec and Inspection was found to be 19 sec. So the bottleneck process is FMG.

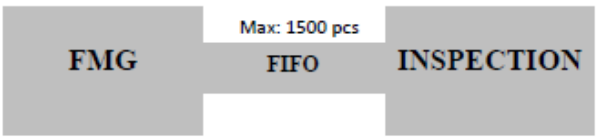


Figure 7: FIFO between two processes

The buffer size was calculated between these processes. The buffer size of 15 trays was obtained. This means one should allow space for 15 trays in the FIFO lane to overcome bottleneck effect of the FMG process.

D. Pull Implementation

For implementing pull system, Kanban cards are the key elements, as it contains the details of number of parts required for succeeding work station to achieve continuous production without delays. So the Kanban card was designed and number of cards was calculated.

The Kanban cards were calculated for the FMG lines for the leveling period. The kanban is calculated using the company standard formula. The table shows the Minimum and Maximum cards required for the leveling period for the FMG loop.

Table 2: Kanban calculation for FMG Lines

Part numbers	Kanban Calculation		
	Daily Requirement	*Max*	*Min*
382	1400	23	9
609	1200	17	10
565	1000	12	6
526	900	10	5
417	2400	24	15
675	2100	10	5

Working of Kanban

For Every two hour once customer (PE customer) pulls the elements from element supermarket and put the respective kanban card in the lot formation Box. Once the kanban cards in the lot formation box gets filled as per the lot size, then lot has to be transferred to production chute by the internal milk-runner. Point of use provider check the kanban cards in the production chute, then takes the plunger and barrel sets from the component super market and detach the kanban cards from the plunger and barrel bin and places into the kanban post. Later kanban card and provides the plunger and barrel sets to the assembly work stations. On the other hand, the detached kanban cards which are placed in the kanban post will trigger the consumed plunger and barrel production in the plunger and barrel loop.

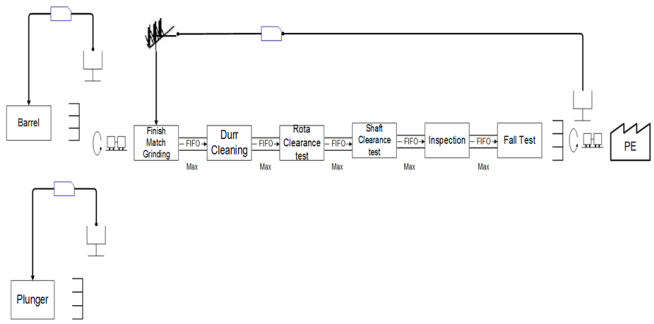


Figure 8: Design of Kanban loop

IV. RESULTS

After designing the Kanban system for the FMG lines, the system was run on a pilot basis to evaluate and measure the performance of the Kanban system with respect to parameters like total manufacturing lead time, inventory, and customer fulfillment.

By implementing pull system in Line 1 and 2, the lead time was reduced to 1.25 days, with improvement of 1.28 days compared with push system.

The lead time of Line 1 = 0.72 days

The lead time of Line 2 = 0.53 days

Reduction of non-value added time in the assembly loops due to the implementation of kanban and FIFO principle enabled

the production line to produce the required parts with reduced lead time.
Reduced lead time in Line 1 = 0.6 days
Reduced lead time in Line 2 = 0.67 days

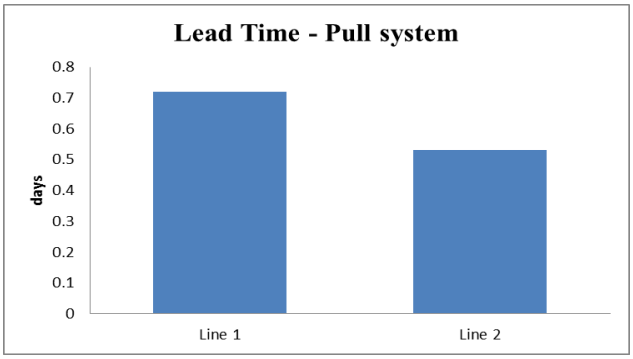


Figure 9: Lead Time of FMG Lines

The inventory data was collected after implementing pull system, the Line 1 inventory was 6480 pieces and Line 2 inventory was 4680 pieces.

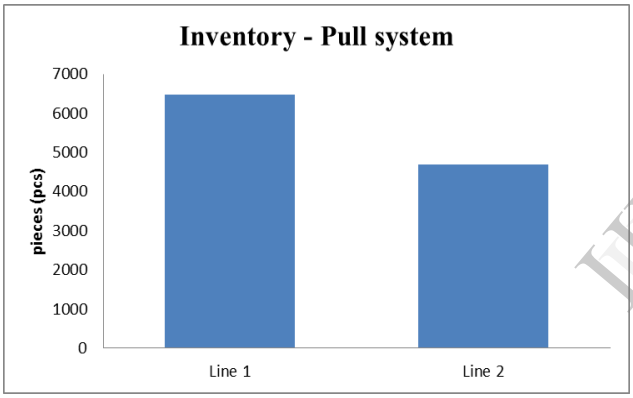
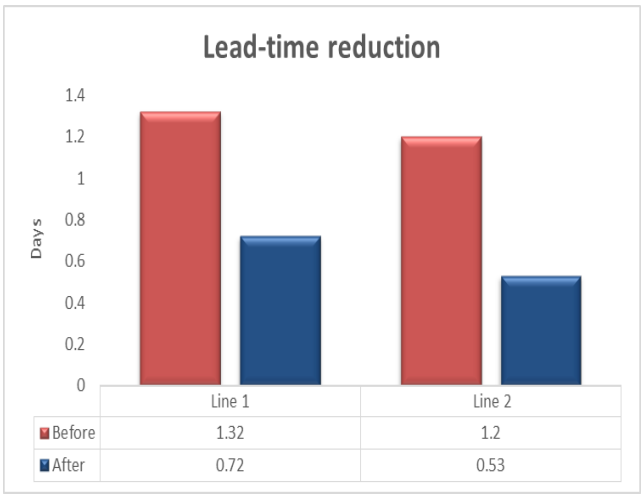


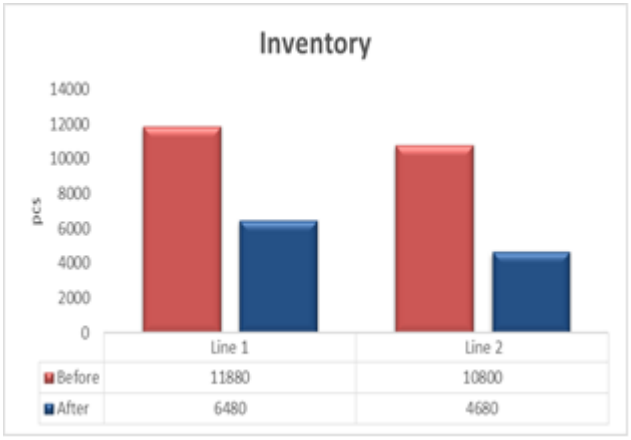
Figure 10: Inventory of FMG Lines

Comparision of Push and Pull system

A. Production Lead Time



B. Inventory



C. Customer Fulfillment

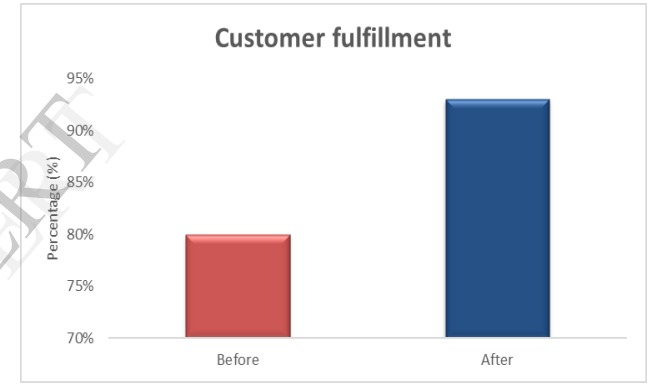


Table 3 shows the Results drawn from the pull system implementation in Line 1 and 2 of Element manufacturing.

Table 3: Push and Pull comparison

Sl. No	Metrics	Push system	Pull system	Improvement
1	Lead Time (days)	2.52	1.25	1.28
2	Inventory (pieces)	22680	11160	11520
3	Customer Fulfillment	80%	93%	13%

V. CONCLUSION

After carrying out the implementation of pull system in Line 1 and 2 of element manufacturing, many improvements in the line were achieved. In this paper, a method of calculating the number of kanbans regarding pull system was standardized. Value Stream Mapping and Value Stream Design techniques were used in the lines to identify the hidden waste present in the production shop floor.

The production lead time for Line 1 assembly loop was reduced from 1.32 days to 0.72 day, thereby leading to 45% reduction in the line. The production lead time for Line 2 assembly loop was reduced from 1.2 days to 0.52 day, thereby leading to 56% reduction in the line.

The inventory in Line 1 was reduced from 11880 pieces to 6480 pieces; the inventory in Line 2 was reduced from 10800 pieces to 4680 pieces.

The customer fulfillment was increased from 80% to 93%; thereby increase in 13% of customer fulfillment.

SCOPE FOR FUTURE WORK

Based on maturity of Kanban system for Line 1 and 2, the Kanban based pull can be implemented to FMG line 3 and Line 4. The Kanban based pull can also be implemented to FMG lines of Single Cylinder pumps. Supermarket concept at supplier stage can reduce further exotics inventory in the value stream.

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