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Implementation of RFID based Kanban System in a Manufacturing Industry

Kevin Thomas[1], Sreyas Tribhu[2], S. P. Anbuudayasankar[3]
[1] B Tech Student, Mechanical Engineering, Amrita School of Engineering, Tamil Nadu, India
[2] B Tech Student, Mechanical Engineering, Amrita School of Engineering, Tamil Nadu, India
[3.] Associate Professor, Mechanical Engineering, Amrita School of Engineering, Tamil Nadu, India

Abstract- Lean Manufacturing refers to the different strategies adopted by companies in order to reduce cost and increase quantity and well as quality by reducing lead times and other anomalies in a production line, which would upset the customers. Hence, as a part of productions and operations, lean manufacturing plays a vital role in the survival of any company. This paper elicits a comparison between the push and pull production system and the advantages of implementing the latter in any manufacturing industry. A kanban based pull system in a manufacturing industry has been depicted in this paper. On a practical level, it has been observed that there is a continuous loss of Kanban cards in between the finishing processes due to which the implementation of the pull system has proved to be difficult. A Radio Frequency Identification (RFID) based Kanban system has been presented in this paper which was applied to an element manufacturing plant to increase the effectiveness of the Kanban system and hence tackle the problem. Value Stream Mapping was done on the current state of the process and future state was designed with a goal to improve the process. The case study conducted includes the method of calculating the number of kanbans as a part of implementing the pull system. The ultimate goal boils down to improving the customer fulfillment with steps taken to reduce the lead time, maintain a minimum inventory buffer size in the supermarket. After an inventory check across the lines, the results show a significant drop in inventory and an improvement in the process parameters leading to customer fulfillment.

Keywords- Lean manufacturing, Pull system, Kanban

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1. Introduction

Lean Manufacturing is the strategy used by most companies today, not only keep their customers, but also reduce the cost to the company. It primarily involves reduction of the non-value added activities giving way to cost reduction. Developed by Toyota Production System (TPS) this has been used in discrete manufacturing comprising of automotive, electronics, white goods and consumer products. Implementation of lean principles in a production line has proved to outweigh excessive and unnecessary capital investment whilst reducing cost [1].

The ideal principles to be followed while applying lean concepts can be briefly summarized as shown in Fig -1.

A systematic approach was used to process the fulfillment of customer orders from the date of the order set by them to the time of delivery of the manufactured product.

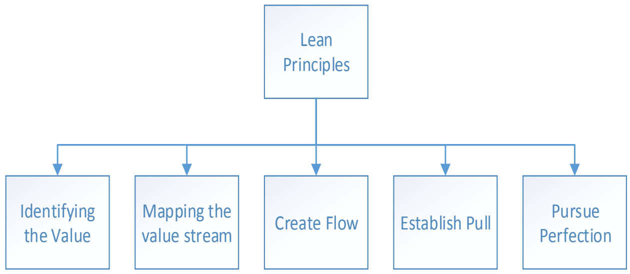

Fig -1: Lean Principles

1.1 Push Vs. Pull

The push production system focuses mainly on sales forecast but consumes a lot of space, involves high costs of overheads and wastes, and invites risks of obsolescence. The Master Production Schedule (MPS) developed with forecasts, and the outputs of Material Requirement Planning (MRP) and Capacity Requirement Planning (CRP) result in increased fluctuations of inventories and lead times. This system allows the supplier to work at his own pace and complete work according to his own schedule as there is no defined agreement between the supplier and the customer. The only control that happens is through changing the schedule and moving the people, but this also leads to additional wastes and variation.

The pull system effectively journeys towards the ultimate goal of zero waste, lowest possible cost, defect free production and shortest lead time [2]. This is done by moving one piece/one set at a time with production volume, pace and mix derived from the customer demand. Total waste elimination and full utilization of material, labor and equipment, thereby lowering production cost is the main aim of the system. A defined agreement, dedication to customers and simple control methods are the three primary elements of pull that distinguish it from push.

2. Product Information

Barrel and plunger are the components of the element which is a part of the fuel injection pump of a diesel engine. Its main function is to deliver pressurized fuel at the right time. The barrel is screwed on to the pump housing and the plunger reciprocates inside the barrel due to a camshaft [3]. When the helix groove of the plunger comes in line with the inlet hole of the barrel, delivery of the fuel takes place.

This paper focuses on the effective implementation of pull system for the production line of barrel alone. The sequence of finishing processes of the barrel production line is shown in Fig -2.

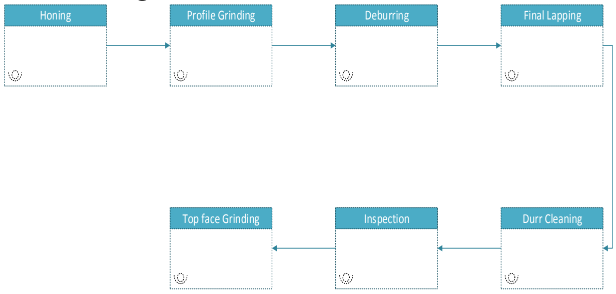

Fig -2: Barrel Process Flow

3. Value Stream Mapping - Current State

The first step of implementing a pull system in a production line is to understand and analyze the present situation using a Value Stream Map (VSM). It is an enterprise improvement technique to visualize the current situation of the entire production process, represent information and material flow and to finally improve the process by identifying the waste and its sources [4]. The inventories between all the finishing processes in the barrel manufacturing line was captured and also information on each finishing processes such as types of parts, number of machine and equipment in the line, cycle time, process time, work in progress, over all equipment efficiency (OEE). Upon completing, the material flow from the supplier to the customer was understood. This information was used to map the current state of the plant as shown in Fig -3. The process time for each process is taken as value added time. The inventories between the finishing processes are divided by the customer time to give the non-value added lead times. We find out that the value added time is 0.66 days and the non-value added time is 13.44 days.

There are six lines in the manufacturing plant that follows the push system. The first line was chosen in order to apply the computer RFID Kanban system. Upon successful application of the system we will be able to apply the same to the remaining 5 production lines.

4. RFID Kanban System

For once in every two hours, the set maker from Heat Treatment section brings the heat treated parts in a trolley to the raw materials supermarket and the kanban cards for that particular part is taken from the production chute and the cards along with the parts are taken for the first process which is honing. After the honing process, the parts along with the cards go for the subsequent processes viz. Profile Grinding followed by Deburring, Final Lapping, Durr Cleaning, Inspection and Top Face Grinding. The machines undergo a changer over after a lot in order to accommodate the different part numbers required by the customers. After the last process, the trays containing the parts and cards are taken to the finished goods supermarket. The set maker from FMG section then pulls the parts from the supermarket once every four hours and the kanban cards are placed in the lot formation box of the respective part numbers. The lot formation box consists of four slots and each slot is allotted for one kanban card. Once the box is filled, the cards are taken from the box and placed in the production chute by the same FMG set maker. These cards will be later taken by the set maker from Heat Treatment section and along with the parts from the raw materials supermarket for honing process.

We have noticed that the Kanban numbers in the loop are never maintained. These losses happen due to a number of reasons,

1. Misplacement of the cards
2. Ignorance of the Machine operator
3. The card tearing

To tackle these problems, the Radio Frequency Identification (RFID) technology was introduced into the system. RFID tags were placed on the Kanban cards and scanners were placed between every finishing process.

RFID tags vary in data storage capacity, power supply, and the range of frequencies it broadcasts. They can be detected from a range of 20 feet to 300 feet away or more, depending on the frequency it transmits. Hence, they need not be positioned on the surface of an object (reducing the possibility of wear and tear) nor does the object have to have a precise position relative to the scanner. The tags also have read and write capabilities so that the data stored on them can be updated when and if required. Another advantage is that the read time is generally below 100 milliseconds enabling the system to detect a large number of tags at a time, thereby offering a better way to keep track of items in the Kanban system.

The machine operator makes sure that the Kanban cards are scanned before being placed in the FIFO chute. RFID tags provide a unique identification to each object it is placed on. In the case of passive RFID tags (which is what we used), an RFID reader emits electromagnetic waves to activate tags within its range. Once activated, the tag uses the power harvested from the electromagnetic waves to transmit the data stored on its microchip back to the reader through radio waves. The reader then interprets the frequencies of the waves it receives from the tag to obtain meaningful data. The data hence obtained is relayed to the main system that the reader is connected to. This helps keep track of all the moving Kanban cards.

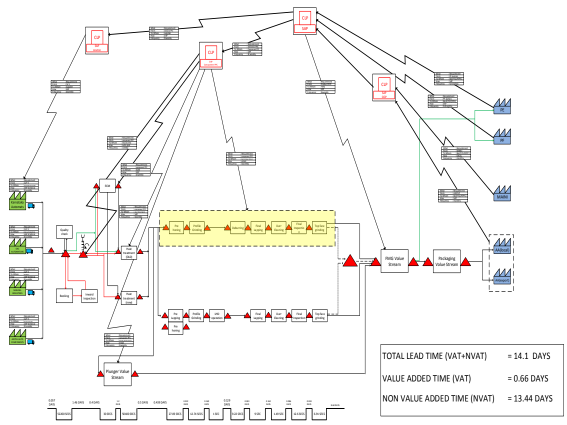

Fig -3: Value Stream Mapping

Tag interference or reader interference is one of the challenges faced when implementing the RFID technology.

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However, this can easily be tackled by adopting a cellular system called Time Division Multiple Access (TDMA). It ensures proper wireless communication by avoiding interference among RFID readers and tags, or with other electronic devices.

Once a card has been missed or tears, the machine operator will be unable to scan the code on the card. This will be notified to the Line Supervisor immediately. The Supervisor will talk to the Foreman who will take immediate action. The Kanban card will be replaced and the RFID of the new card will be updated in the computer system.

We have taken three parts that are runners in the first line for the Kanban calculation.

4.1 Calculating optimum number of kanbans

Kanban number represents the total amount of material that is allowed for the production. Based on the types of barrels produced, these parts are classified into three categories i.e. runners, exotics and strangers depending on the frequency of production. Runners are the most frequently produced parts followed by exotics and finally strangers. The requirements are calculated on a daily basis which is equal to 30000 pieces. The daily requirements are rounded up based on the given Standard Number of Parts (SNP) of 100 pieces and this represents the lot size. In this case, 100 pieces fit in one box which is accompanied by one single kanban.

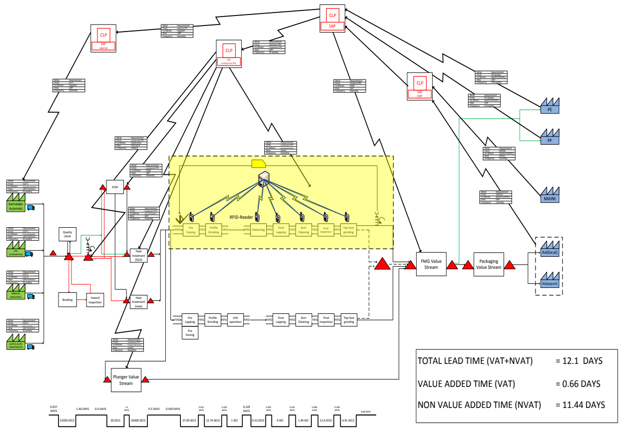

Fig -4: Value Stream Design

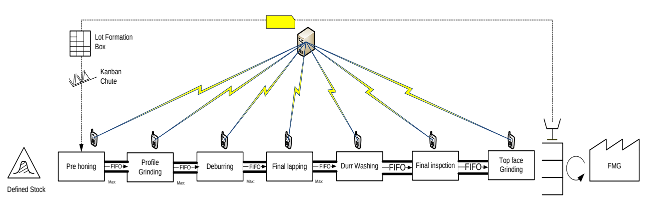

Fig -5: RFID Kanban Loop

Three barrel part numbers namely A058, V170 and V006 which belong to the runners category are taken up for this case study and the number of kanban cards are calculated for each of them. The calculations by Sudhakara, Salgado are followed [5][6] and the following results are obtained as tabulated below.

5. Value Stream Design – Future State

After the mapping of the present situation, it is necessary that in order to achieve an optimal condition, implementation of the lean principles is mandatory. The existing push system is replaced by FIFO between the finishing processes [7]. FIFO amount is determined by the summation of the time loss due to the difference in delivery takt times, time loss due to change over and time to produce one number of parts per kanban (NPK). This makes sure of a continuous flow in materials with minimum stack up of inventories. The Kanban system is implemented and the RFID ensures that the number of kanban cards is maintained for optimum production. The future state is mapped applying this and hence, an effective Kanban system.

Fig -4 depicts the future state of the map after the implementation of RFID system in the kanban loop. The enlarged view of the loop is shown in Fig -5.

Table -1: Calculated number of Kanban cards

S No.	Barrel Part Numbers	Maximum Cards	Total Cards	Minimum Cards
1.	A058	22	27	2
2.	V170	41	51	19
3.	V006	12	15	6

Table -2: Push vs. Pull Comparison

S No.	Metrics	Push System	Pull System	Improvement
1.	Lead Time (days)	14.1	12.1	2
2.	Inventory (pieces)	443,520	377,520	66,000

6. Result and Discussion

After designing the kanban system for the barrel production line, 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 [8].

The results shown below are a comparison of the push system versus the pull system with respect to the total lead time incurred and the inventory levels.

Therefore, it is observed that there is a decrease in the lead time and inventory by implementing the kanban based pull system and thereby reducing the cost to the company and increasing the customer fulfillment.

7. Conclusion

After carrying out the implementation of pull system in barrel production line, many improvements in the line was achieved. In the case study conducted above, the method of calculating the number of kanbans as a part of implementing the pull system was standardized. VSM and VSD techniques were applied to study and identify the hidden wastes present in the production shop floor which were eliminated by effective implementation of the kanban system.

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