ABSTRACT

This research paper is based on the research work carried out at MFN-1 (Manufacturing Nozzles) Shop Floor at Bosch Ltd. Nashik. It is found that the earlier push system of manufacturing process needed maximum manual intervention, machine hours and calls for some errors. This resulted in accumulation and piling up of inventory which affected timely delivery of material and degraded the overall productivity. Because of this problem the Throughput Time (TPT) for process was more. So, MFN-1 Shop Floor at Bosch Ltd. was lagging behind to fulfill daily customer demand.

This paper highlights the Lean Practices implemented for minimizing manual intervention, reducing Lead Time and also the OEE improvement. The research work dealt with concept of KANBAN and Pull System to standardize the process and optimize resource utilization and material availability.

Using KANBAN method tagging of bins and FIFO racks containing raw material and semi finished good was done which contains code number, part name, quality, supplier and customer. This method was used to control the production and material flow to support the pull system. Also the Supermarket concept is being implemented to store parts between supplying and consuming production steps which guaranteed delivery to the customer even if there are problems in production processes. The implementation of Lean processes at MFN-1 Shop Floor led to the clear path for material movement, quick Throughput Time, timely delivery of material.

1.0 Introduction

BOSCH Limited in India Nasik plant is specialized in manufacture of components of fuel injection equipment, especially Nozzles and Injectors for automobile industries, both in conventional (non-Euro) and Euro series applications. The product application is in automotive, stationary engines, marine and in locomotive segments for both inland & export markets.

Lean is defined as set of principles, not only the process that can be replied across environment. Lean is structured on some prime pillars such as Pull System, Continuous Flow, Customer value, Waste Elimination and Continuous Improvements. In the PUSH system the order is started in a superior planning level in direction of material flow with finish date and order number. With the PULL system the order starts on customer demand contrary to the material flow and without finish date and order number.

2.0 Literature Review

(Stock & Lambert, 2001) highlights that Materials handling makes production flow possible, as it gives dynamism to static elements such as materials, semi-finished products, equipments, layout and human resources. Despite its importance, materials handling is a topic that frequently is treated superficially by the companies. (Asef-Vaziri & Laporte, 2005) attributed to material handling and the most critical material handling decisions in this area are the arrangement and design of material flow patterns. An important aspect of any production system is the design of a material handling system (MHS) which integrates the production operations. (Bowersox and Closs, 1996) provides, the main logistic responsibility in manufacturing is to formulate a master-program for the timely provision of materials, components and work-in-process. Logistics (including materials and goods flowing in and
out of a production facility as well as its internal handling) has become very important to an organization to acquire competitive advantages, as the companies struggle to deliver the right product at the correct place and time. The main challenge is to promote, with low cost, a flow whose velocity allows the execution of manufacturing process with the expected satisfaction level. (Gaither and Frazier, 2004) states the importance of layout, which defines the placement of equipment and, consequently, restricts possible routes and sequencing, can be perceived by the prominence that the subject is treated in production management literature.

3.0 Need of the study

Initially there was Push system that is the material was pushed to the line. It is supplied at continuous interval without the requirement of material. The material is replenished on continuous interval to the line leading to high inventory cost. The super market was far away from the process line. So, the line feeding operator has to travel a lot for feeling the trolleys. There were chances of parts damage and time required for line feeding was more. So it was necessary to optimize the material movement. Considering the problems faced by Company, the Researchers have decided to work in the area of “Lean Implementation” by using Pull system with KANBAN principle to attain cost effective result.

4.0 Statement of the Problem:

It was not feasible for production line to supply material on time and in required quantity. In addition to it, the time taken by the line feeding operator was more as he has to travel more to feed the line. Moreover, the space in the shop floor was not efficiently utilized to store the inventory items. Thus, the researchers decided to take the research work entitled “Lean Implementation by Executing Self Running Loop in MFN-1 Shop Floor at Bosch Ltd.”

5.0 Objectives

• To improve overall efficiency through material availability at right time & right place.
• To ensure minimal and smooth material & information flow through Production process.
• To standardise the processes and working environment and optimise resource utilization and material availability.
• To utilize available resources effectively for reducing inventory and logistics cost.

6.0 Scope of the research work

This Research work will help Bosch Ltd. in developing the concept of Self running loop for Soft Stage at MFN-1(Shop Floor), initiate the changes in accordance with process improvement. standardise the processes and working environment to optimise resource utilization and material availability. It will also help employees at Bosch Ltd. in adopting and following Lean Practices for Operation Excellence and less manual intervention and reducing lead time.

7.0 Limitations of the Study:

It was a difficult task to gather all the information regarding the working of all departments in MFN-1 as the manufacturing department has continuous operations. There was difficulty in interaction with the operator is faced. There was resistance from employees to adopt new changes.

8.0 Sources and Method of Data Collection:

The primary data is collected by researchers by direct observation at the MFN-1 Shop Floor and layout study to trace the movement of material (raw as well as semi-finished jobs). The data is also collected by interacting with front line Managers and operators. The secondary data is collected using company manuals, departmental records, journals and internet.
9.0 Data Analysis

The data, after collection, has to be processed and analyzed in accordance with the outline laid down for the purpose at the time of developing the research plan. MFN 1 manufactures three kinds of nozzles DLL, DN and DL. Each of these major categories has approximately 350 subtypes of nozzles. Out of the 3 types the production levels of DLL is highest. DLL is German term (Loch-Düsen Länge).

There are two stages in Production viz. Soft Stage and Hard Stage, So among those Researchers concentrated on Soft Stage. Self Running Loop is an Output – Input coupling which provides closed synchronization of Input by Output without manual intervention where production process is mainly triggered by signaling tools like KANBAN.

Fig. 1  Consumption control loop in VSM

This Consumption-controlled loops consist of flows of information and material and it works with a FIFO production process and the lot size formation takes place before the production chute. Hence for this the loops must be closed. In this, Material flow is from Left to Right whereas information flow is from Right to Left.

9.1 How just in time is implemented?

By establishing JIT, a company can approach toward zero inventory. Also reducing change over times for modernizing industrial automation process. To implement Just in Time, the researchers have taken help of tools like Supermarket and KANBAN.

9.2 Supermarket:

A supermarket is an area to store parts between supplying and consuming production steps. Task of a supermarket is to guarantee delivery to the customer even if there are problems in production. Supermarket covers demand of downstream process and supermarket allows visualization of the situation in production (problems). The researchers have prepared tags for materials to be replenished in supermarket.

Fig. 2  Sample KANBAN Card
The specification on KANBAN card are individually tagged on Supermarket so that it will help out supplier for efficient replenishment of material. The tag contains Part Number and Part description, Quantity, Internal supplier and customer. Supermarket is having tags for replenishment of material (Safety stock, Minimum quantity required and Economic Order Quantity).

9.3 KANBAN:

Kanban card is a carrier of information between the customer and the supplier. It contains code number, part name, quality, supplier and customer. It is a method used to control the production and material flow to support the pull system. Manufacturing/Assembly is carried out only if the Kanban card is present. The number of KANBAN cards is an indicator of Inventory levels. Through this KANBAN system researchers were able to provide control methods for achieving optimization of material flow. This has ensured the optimised delivery performance and material availability at right time, right place and in a right quantity. It is possible to divide work into small value adding increments, that can be independently scheduled. The rate of delivery of customer valued work into production. And for this two major variables which regulates the Throughput those are; WIP (Work In Progress) and Cycle Time.

9.3.1 Factors influencing the number of Kanbans

- Replenishment lead time
- Planned customer demand/customer pick-up behavior
- Lot size (The number of parts that can be manufactured between two changeovers)
- Number of parts per Kanban (NPK)
- Value stream output and stability of processes
- Planning accuracy of the customer demands

The researchers have assisted to derive KANBAN formula with R & D team of Bosch for optimization of material availability. The details of formula and respective calculations are as follows.

9.3.2 Kanban Formula:

\[ K = RE + LO + WI + SA \]

9.3.3 RE Calculation:

The number of Kanban for RE is calculated as follows:

\[ RE = \frac{RT_{Loop}}{TT_{Part.no.} \times NPK} \]

or with

\[ TT_{Part.no.} = \frac{POT \times PR}{PR} \]

\[ RE = \frac{RT_{Loop} \times PR}{POT \times NPK} \]

RT Loop [time] : Replenishment Time  Replenishment lead Time for part number
NPK [units]: Number of Parts per Kanban number
POT [time/period]: Planned Operating Time
PR [units/period]: Period Requirement Demand for part number during period
TT Part no. [time/unit]: Customer Takt Time  
Calculation of customer Takt Time:
Customer takt time (TT) = \( \frac{\text{planned operating time}}{\text{Average customer demand/day}} \)

Example with sample readings:
Considering Production of DLL-S type Nozzle in MFN-1,
The Average customer demand per day is about 14000 units
Plant Operating Time: 8 Hrs per shift = 28800 sec
  30 min Lunch Time = 1800 sec (less)
  15 min Tea Break = 900 sec (less)
Hence 28800 – 1800 – 900 = 26100 sec per shift
Since there are 3 shifts per day, POT/ day = 26100 * 3 = 78300 sec per day
Therefore, Customer takt time (TT) = 78300 / 14000 = 5.6 sec/ unit

9.3.4 LO Calculation of individual parameters
The number of Kanban for LO is calculated as follows:

\[
\text{LO} = \frac{\text{LS}}{\text{NPK}} - 1
\]

\[
\Delta \text{RT}_{\text{Loop}} = \frac{\text{RT}_{\text{Loop}}}{\text{TT}_{\text{Part no.}} \times \text{NPK}}
\]

\[
\text{PR} = \frac{(\text{LS} - \text{NPK}) \times \text{TT}_{\text{Part no.}}}{\text{TT}_{\text{Part no.}} \times \text{NPK}}
\]

9.3.5 WI Calculation:
The number of Kanbans for WI is calculated as follows:

\[
\text{WI} = \frac{\text{WA}}{\text{NPK}} \cdot \text{RE} - \text{LO}
\]

WA [units]: Withdrawal Amount
maximum PLANNED cumulative withdrawal amount of customer demand for part number within RTLoop
NPK [units]: Number of Parts Per Kanban Quantity for KANBAN

9.3.6 SA Calculation (Safety Factor)
The number of Kanban for SA is calculated as follows:

\[
\text{SA} = \text{SA}_1 + \text{SA}_2 + \text{SA}_3
\]

9.3.7 KANBAN Calculations for DLL soft Stage:
With reference to the available data and existing parameters, Researchers made the following Calculations for Transport KANBAN for month of July 14:
These KANBAN calculations will help organization in synchronization of assembly, production, and sales rhythm and assembling or manufacturing, based on the customer demand.

10.0 Findings:
Researchers carried out a trial run for two weeks was conducted after implementation of Self Running Loop, it was found that time taken for provided runner type that is Throughput Time (TPT) was reduced by 30% and following benefits are being observed.
1. Effective utilization of available resources
2. Less Intervention of Operator required
3. Lead Time reduction
4. Reduction in Inventory
5. OEE Improvement due to material Availability.

11.0 Suggestions:
• Considering the benefits and achieved improvements in provided runner type after Self loop Implementation, the Value Stream in MFN-1, Researchers suggested to implement the same for other types. There are about 16 Runner types over the Value Stream (Bosch, NaP).
• The researchers has suggested the management of Bosch to arrange Training and Development Programs as well as Simulation Workshops for the Employees which will help in building an awareness for adopting Lean Practices for better Productivity.

12.0 Conclusion
The researchers contributed for Enhancing Visualization Process through Tagging the Identification & Instruction Labels on DLL Soft Stage Machines at MFN-1 Shop Floor. These Visual Tags are helpful for Employee and Organization in terms of: the clear path for material movement, quick Throughput Time, Timely delivery of material.
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