Redesigning of Production Line from Lean Manufacturing Tools by using VSM for a Screw Manufacturing Firm

Subbarao Chamarthi[1], Freedon Daniel[2], Harshit Sharma[3]

[1,2]Asst.Prof, Mechanical Engineering Department, SRM University, Delhi-NCR Campus, Delhi, India
[3]Student, Mechanical Engineering Department, SRM University, Delhi-NCR Campus , Delhi, India

Abstract—*Industries in the present time are competing with each other in order to increase, productivity, profits, and business. Lean manufacturing tools are beneficial for a manufacturing industry, as these can increase leanliness in respective industry. This research paper presents a case study of a screw manufacturing firm located in north region of India (Sahibabad). The basic purpose of this research paper is to conclude the effect of redesigning manufacturing line of respective screw manufacturing firm; two improvements are taken into account based on lean manufacturing. First, improvement is using kanban cards for storage of different type of screw, secondly, improvement through milkrun process. This case study illustrates VSM use, as well as kanban and milkrun systems application on an assembly line. The result of 3 different months is considered. Finally, the results obtained show the path of improvement, measured through the lean rate (LR) and dock-to-dock time (DtD).*

Keywords— Lean manufacturing tools, VSM, LR, DtD, Milkrun process, Karban cards.

I. INTRODUCTION

Lean manufacturing tools are basic and most priorities requirement for manufacturing industries. In this case study lean manufacturing tools like kanban cards for storage of different type of bolts and milkrun process are applied over screw manufacturing line, VSM(Value Stream Mapping) is being used for each and every month, where VSM is a method for analysing the current state and designing a future state for the series of event that take place from its beginning through the customer. The result obtainted from both improvement is then measured by lean rate (LR) and dock-to-dock time (DtD), where DtD depicts the material flow through the value stream, the time it takes for material to flow from the receiving dock (or order entry point) to the shipping dock and LR is the ratio of working time of added value to DtD or through put time. In this paper a case study is done on a screw manufacturing industry located in north India (Sahibabad). These industries manufacture different size of screw. The manufacturing of screw follows some steps. Firstly, wire is feed into machine, cutting of wire, heading of screw with the process of cold frodging as shown in figure 1, diesel oil is used for lubrication, headed screw is then transferred to a thread cutting machine, which also produce scrap material which can be used again to drawn into HHB wire as shown in figure 2. Different type of screw such as, combination Philip head screw, truss head screw etc as shown in figure 3. These 4 type of screw are contained in drum type container as shown in figure 4.

Fig.1:Screw frodging machine

Fig. 2: Screw threading machine

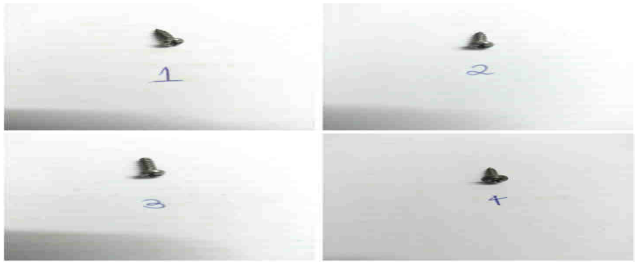

Fig.3: Types of screw

Fig. 4: Container for different screws

II. METHODOLGY

Methodology is based on the continuous improvement. Consequently, it will be a continuous process of status study, calculation of metrics, implementation of progress, observation of the results, and new decision-making of improvement. A first design of VSM is realized according to the original data from production processes and the layout, identifying the key times of each workstation. This design represents the starting point of improvement. Next, the map of the parts flow is shown to verify the materials movement between the workstations, calculating the productive and unproductive times, stocks and metrics that will help to characterize the process, and marking some targets of progress. This design of the VSM allows the beginning of the progress in the manufacturing line. Metrics used are DtD and LR. DtD depicts the material flow through the value stream, the time it takes for material to flow from the receiving dock (or order entry point) to the shipping dock (Eq. 1). LR is the ratio of working time of added value to DtD or throughput time (Eq. 2):

DtD = Time for material flow through value stream, (1)

$$LR = \frac{\text{Added value work time}}{\text{DtD}} \quad (2)$$

Next, the necessary progress will be implemented to achieve the desired state of the manufacturing process. There are two main improvements: firstly, it is a system to control storage of different type of screws (kanban system), and in addition, it allows improving the material flow between workstations to obtain a more flexible process, optimising the job of each workstation (milkrun). Every 2 months, a new VSM is checked and metrics are recalculated and analysed to control improvements.

III. INITIAL VALUE STREAM MAPPING

The initial value stream mapping is done on the basis of present state of manufacturing industry, which follows a particular type of process and takes required number of days to complete one operation; this all is shown in VSM. Presented VSM in figure 5 represent for the month of April. In this VSM there are different station on which different operation for manufacturing screw is to be performed, followed by some of storage. The process starts from receiving a stock of HHB grade wire, which is to be used for manufacturing screw, this wire can be delivered from any HHB wire manufacturing industry, after that these wire of different dimensions are divided into different lot, different dimension screw need different dimension wire. One lot with required type of screw is feed to station 1 where screw frodging machine frodge the screw in required shape, as screw are frodged in large quantity so they are divided into further lots, after that each lot is send to station 2 for threading operation, threaded screws and scrap metal produce due to threading move to station 3 where separation of screw from scrap metal, the scrap metal is stored in storage 1 and discarded, where selected screw are stored in storage 2. The final calculations of DtD and LR provide the following results: DtD=13.80 days and LR=0.380%. These metrics have been calculated without the external stores, so they only depend on what happens inside the factory. The amount of parts stored at the different critical points is also very important. One of the improvement objectives is to increase leanliness in respective screw industry. Similar to this each and every type of screw follow same VSM.

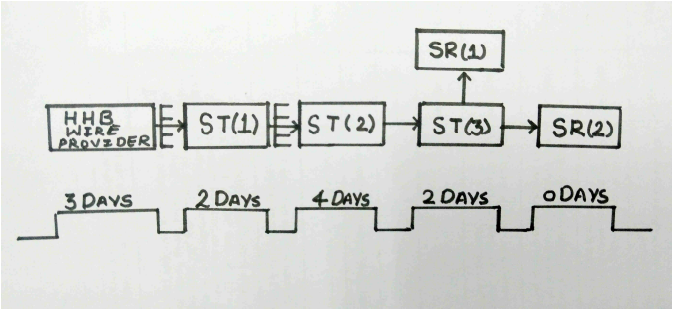

Fig. 5: VSM for April month

IV. IMPROVEMENTS

1. First improvement- using kanban cards for storage of different type of screw.

Kanban cards are used for different purpose to provide leanliness in a manufacturing industry. Kanban cards are very effective technique of lean manufacturing tools. In this case study, kanban cards are used to provide the data which ease the storage of different type of screw, in particular type of container in proper manner, as present way of containing screw is not up to the marks, so the improvement in storage of different type of screw is to be done with the use of kanban card, figure 6 shows the design of kanban card which is to be used for presenting a particular container, with particular type of screw. In provided Table 1, containing lot number represent the lot value as well as container number, after that type of screw contains the information about the type of screw in that particular container, also kanban cards also provide the information of net quantity present in that container (as screw quantity is to be measured in kg).

Table.1: Information on storage kanban cards.

Storage Information
Container number – Type of screw –

Net Quantity (Kg) -

2. Second improvement- Milkrun process

To create a fluid flow of screw lot, two decisions must be taken. The first one is related top conveyor. A kind of conveyor must run through without any interruption. Firstly, from station 1 frodged screw lot is transferred through conveyor to station 2 where threading of screw is to be done, after that lot of threaded screw is passed over a conveyor which have scrap separation system, separate the scrap from screw, scrap lot is collected in a container while sorted screw lot is transferred over conveyor to its container. This conveyor must have the capacity to transport the lots between stations. After several studies of capacity, distance, speed, and easy handling, the best solution can be provided to improve the system. The second one is to establish the route for the milkrun, so it was necessary to consider: (1) the rate of material consumption and calculate the speed of assembly line (2) the amount of tray needed for each station. Thus it is necessary to establish milkrun routing and visit frequency to work station. After realizing the diverse stage of trips, need, and times, the routes were established. Fig. 7 shows the VSM after improvement for month of November.

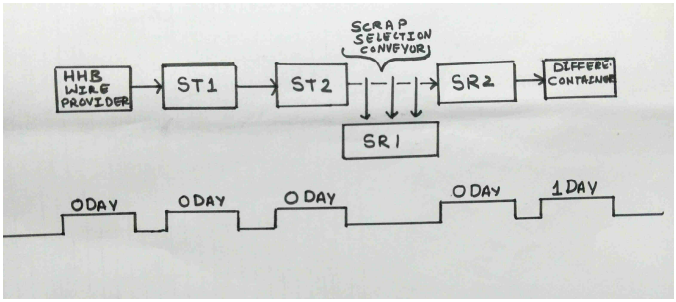

Fig. 7: VSM for month November

V. RESULT OF IMPROVEMENTS

A case study results have been evaluated across VSM diagram. The calculation of several critical magnitudes indicates if the manufacturing process improves or deteriorates according to the criteria previously established. The metrics, LR and DtD, have been improved. DtD is reduced from 13.80 days in the VSM of the month of April to 11.5 days in November. LR is increased from 0.38% to 0.44% at the same time. Global results in explain the milkrun effects to improve the metrics that had not got better between April and August in spite of storage kanban implementation. Lean manufacturing has significantly improved the parts flow. It is possible to see in figure 8 and figure 9 that the DtD and LR results obtained with the second analysis are worse than the first one; nevertheless, it is possible to appreciate good tendency with reduction of stocks. The changes do not produce an instantaneous progress. .Work people need to become familiar with the new habits of work. The analysis of the third month with milkrun and storage kanban fully implemented shows a clear progress in both metrics and accumulated stocks.

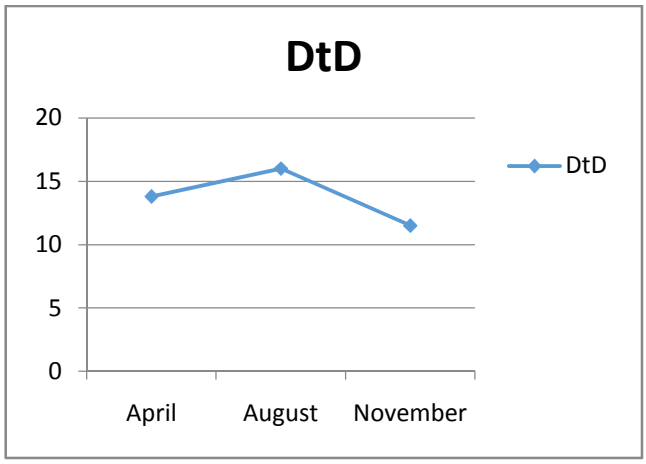

Fig. 8: Graph for DtD Values

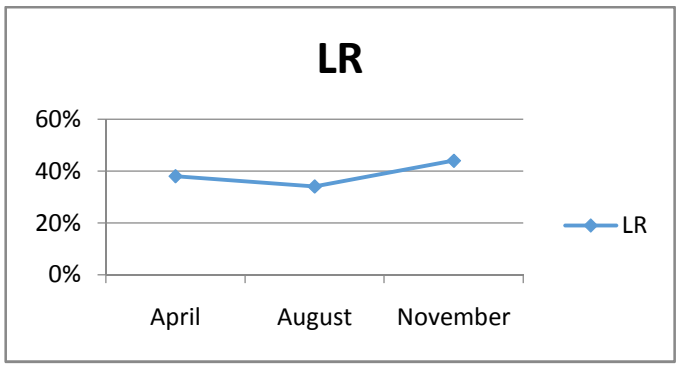

Fig. 9: Graph for LR values

VI. CONCLUSION

This paper provides a case study of a screw manufacturing firm located in northern region of India (Sahibabad). In this case study, manufacturing line for screw industry is accounted and VSM are drawn according to the improvement and original manufacturing line for different months. The redesign of an assembly line by mean of lean tools, which connects assembly line by mean of lean manufacturing tools, which connects manufacturing design objective to operational objective. By redesigning the manufacturing line of screw industry through storage kanaban cards and milkrun process, industry efficiency increase and time wasted due to improper manufacturing line is eliminated and after the improvement, each manufacturing line for all type of screw works with maximum efficiency, which increases the production rate of respective industry, and lead the company towards profit. The lean manufacturing tools used for this case study with the help of VSM, followed by DtD and LR leads the overall result of industry towards maximum leanliness, high production rate, and highly efficient phase.

REFERENCES

[1] ElMaraghy HA (2005) Flexible and reconfigurable manufacturing systems paradigms. Int J Flex Manuf Syst 17(4):261–276 doi:10.1007/s10696-006-9028-7.

[2] Shah R, Ward P (2003) Lean manufacturing: context, practice bundles, and performance. J Oper Manag 21(2):129–149 doi:10.1016/S0272-6963(02)00108-0.

[3] Smeds, R. (1994) 'Managing change towards lean enterprises', International Journal of Operations & Production Management, Vol. 14, No. 3, pp.66–82.

[4] Álvarez R, Calvo R, Peña MM, Domingo R (2007) Improvement of parts flow of an assembly line applying lean tools. In: Proceedings of the 2nd Manufacturing Engineering Society International Conference (MESIC), Madrid.

[5] Chan FTS (2001) Effect of kanban size on just-in-time manufacturing systems. J Mater Process Technol 116(2):146–160 doi:10.1016/S0924-0136(01)01022-6.

[6] Abdulmalek FA, Rajgopal J (2007) Analyzing the benefits of lean manufacturing and value stream mapping via simulation: a process sector case study. Int J Prod Econ 107(1):223–236 doi:10.1016/j. ijpe.2006.09.009.

[7] Kumar CS, Panneerselvam R (2007) Literature review of JITkanban system. Int J Adv Manuf Technol 32(3–4):393–408 doi:10.1007/s00170-005-0340-2.