Implementation of lean through bottleneck analysis: a case study of a press manufacturing industry

Kashmir Singh Ghatorha[1], Rohit Sharma[2]

[1,2]School of Mechanical Engineering,

Lovely Professional University, Phagwara, Punjab, India.

Abstract

Any manufacturing industry needs continuous improvements in its work efficiency to serve its customers at low manufacturing costs. There are several causes that can result in the slowdown of the work processes but bottlenecks are more serious. This study is based on the identification and removal of a bottleneck process in the press manufacturing industry to reduce the cycle time. The study is conducted on an air tank used in the press and the cycle time of its manufacturing is reduced by 6 hours.

Keywords Lean manufacturing, Bottleneck analysis, Cycle time reduction, Productivity improvement.

1 Introduction

The prime motive of every manufacturing industry is to produce at the lowest possible cost. This leads to continuous improvement programs in the industries to find out the possible potentials of improvements and the elimination of non-value added activities. A bottleneck is a section in the production line of the industry where work can get backed up and it affects the work flow of the production line.

It is very important to perform the bottleneck analysis to find out such unnecessary accumulations and their causes in the work flow. A bottleneck analysis involves the collection of complete data followed by a detailed analysis of the manufacturing flow of product or process in a production line. This analysis not only helps in finding the current problems in the work flow but provides enough sight to identify the processes where bottlenecks may develop in the future. The simplest form of bottleneck analysis of a particular process has the following steps:

a) Data collection: In this step, the data related to work flow in a particular process is gathered in the form of process charts. These charts show every activity of the process sequence wise.

b) Measurement of cycle time: In this step, the information regarding the time required to complete every activity of the process is gathered.

c) Identification of bottleneck activity: In this step, the activity with the highest processing time is identified. That activity is responsible for setting the overall cycle time of the process. Any reduction in the cycle time of the process will be possible only through improvement in the processing time of that activity.

d) Analysis of bottleneck activity: This step deals with the detailed analysis of the bottleneck activity. The motive is to find out the waste which may be resulting in the high processing time of that activity or to find out the new ways of doing work to reduce the processing time.

There are several potential solutions to eliminate bottlenecks. The selection of solution will depend upon the type of bottleneck identified during the analysis. Some common options that can be considered to eliminate the bottleneck are given as under:

a) Addition of workstation or staff to the process identified with low production capacity in the production line.

b) Adjusting the work flow through elimination or changing the sequence of a particular process where bottleneck develops.

c) Elimination of the non-value added activities involved at the bottleneck process to achieve waste-free smooth work flow.

The bottleneck analysis not only improves the current workflow of the production line but helps in building knowledge about the production line which will be beneficial in predicting future bottlenecks in the existing production line. That knowledge will be helpful in the decision-making process.

2 Literature review

Seidel and Arndt applied a productivity assurance program for strategic productivity improvement in complex job shop environments where a multitude of technological and non-technological factors are involved. The study suggested that this method as compared to other existing productivity improvement methods is easy to apply and does not require complex evaluation procedures for the determination of meaningful parameters on which improvement decisions can be made. This methodology consisted of the following main steps: 1) Identifying the general requirements of high productivity set by a company's specific type of production process, 2) Analyze the company's position and productivity levels concerning these requirements, 3) Identify opportunities for productivity improvement, 4) Develop improvements, 5) Implement improvements, 6) Monitor the result and go back to step no.2 [1]. Chandra achieved a saving of 3.35 hours in processing time in a manufacturing unit through the application of work study. The main focus was on the application of time study and method study techniques. The study discussed how these techniques help in eliminating the unnecessary waste and in the design of improved ways of performing the job in minimum time [2]. Al-Saleh worked in the inspection station of a motor vehicle for the improvement of productivity. The research work used the time study and motion study techniques to identify and eliminate the bottlenecks in the inspection process of the vehicle. The ARENA software was used to estimate the results that can be achieved through the suggested changes. The methodology adopted in the study had the following steps: 1) Process mapping, 2) Bottleneck identification through analysis, 3) Eliminating the bottlenecks through motion study, 4) Standard time calculations for the new methods developed. The tools used for data collection are operation charts, flow charts and man-machine charts. Through motion study, new hand motions were introduced and the non-value

added motions were eliminated in the inspection stage 1 of the periodic inspection process. The study achieved a productivity improvement of 174.8% in the inspection of the vehicle [3]. Hassanali improved the productivity of a construction equipment manufacturing industry through the application of work study techniques. The main focus of the study was on the improvement of material utilization and worker productivity. The study found under utilization of the available resources in the yard area. The method study was used to understand the current operations conducted. The analysis of the existing operation resulted in the development of the proposed productivity model. The techniques used to collect the data were operation charts, string diagrams and flow charts. The development of improved methods through the new productivity model resulted in the improvement of worker's attendance and inventory within one month of the installation of the new model [4]. Hemanand et al worked in the automotive industry to improve productivity through the application of lean manufacturing techniques. The target of the study was to reduce the unnecessary motion wastes hidden at various points of the production process. The methodology adopted includes the detailed study of the plant layout and process mapping of the plant followed by the identification and elimination of bottlenecks or wastes. The process flow charts and time study technique was used for the data collection. The study found a high idle time of workers and a lot of material handling through manual means. The study worked on the improvement of the plant layout to reduce the unnecessary motion waste resulting in the operator idle time and high material handling time. The study used the gravity feeder to connect all the machines to reduce material handling time. The positions of different machines changed to balance the line and eliminate the operator idle time. A delivery window was opened between two stations to reduce the material handling motions. The study achieved an 11.95% increase in the productivity of the plant [5]. Khatun used industrial engineering techniques like work study and capacity study for productivity improvement in the garment industry. The study started with the use of the method study technique in order to record the detail of current operations along with the time taken by these operations. The time taken was obtained by the use of the time study technique. The breakdown method was used in the study to note the various elements (in sequence) involved in each operation. The study developed a plant layout that helped in efficient bundle tracking, eliminating lot mix-up, use of self-inspection and increased worker efficiency. The study also discussed the role of industrial engineering techniques in productivity improvement by comparing the two different set of industries [6]. Athalye et al worked in the automobile industry to reduce the cost with the help of industrial engineering tools. At first, the importance and use of various industrial engineering tools was studied through the help of questionnaire and personal interview techniques. The study concluded that the use of cost reduction tools has increased a lot than other methods in last 10 years. The study was conducted in the stamping unit of the industry with the aim of reducing the operation cost. The double die hold technique was used to increase the productivity of the 600T press. The work reported Rs 1877088 saving annually [7].

3 Methodology used

The bottleneck analysis is used to reduce the cycle time of the air tank used in press manufacturing. The methodology adopted in the study is shown in figure 1. In the first step, the data related to air tank manufacturing is collected in the form of an outline process chart. The time taken in each activity of the

process is recorded through a stopwatch. The flange fitting activity is identified as the activity with the highest processing time in the whole manufacturing process of the air tank. The detailed analysis of the identified activity is further done to find out the possible wastes in the form of non-value added activities or to develop new ways of doing work so that the overall cycle time can be minimized.

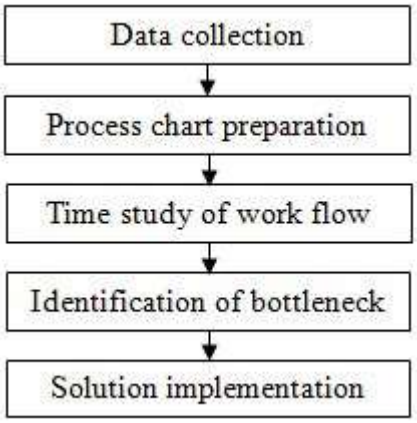

Fig. 1 Flow chart of the methodology used

It has been found during analysis that the flange fitting is done on both sides of the air tank through welding in the fabrication shop. This activity involves two different setups of the air tank. Due to the large height of the tank, a platform and railing arrangement as shown in figure 2 is required before the start of the actual process which adds more time to the setup of the air tank. It is further analyzed that these two setups, platform and railing arrangements are required to keep the flanges in proper position during the welding process.

Fig. 2 Platform preparation

To reduce the cycle time of this activity a fixture is developed as shown in figure 3. This fixture helped proper positioning of the flanges on the air tank when it is placed horizontally in the previous activity. This results in the elimination of the two setups, platform and railing arrangement performed earlier in the flange fitting activity.

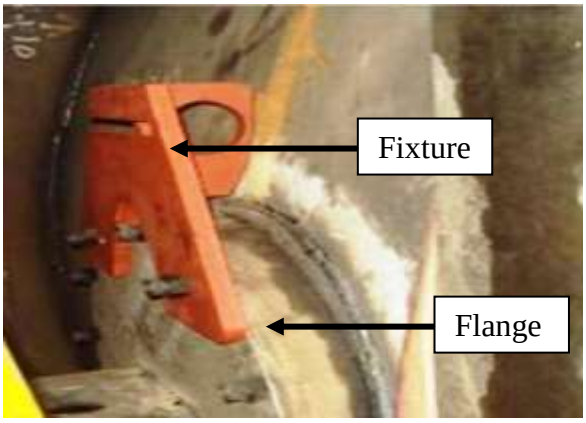

Fig. 3 The fixture used for flange fitting

4. Results and discussion

The use of the fixture has resulted in the elimination of two extra setups done for the flange fitting activity. The fixture helped in the completion of flange fitting activity in the setup performed in the previous activity in which the air tank was placed in the horizontal position. This has further eliminated the use of platform and railing arrangement due to the change in the position of the air tank. The savings obtained through the use of fixture are summarized in Table 1 given below:

Table 1 Savings obtained after bottleneck analysis

Sr.	Activity	Old method	New method	Savings
		Time taken (min)	Time taken (min)	(min)
1	Setup 1	90	0	90
2	Flange fitting	60	60	0
3	Platform and railing arrangement	180	0	180
4	Setup 2	90	0	90
5	Flange fitting	60	60	0
	Total savings			360

5. Conclusion

The bottleneck analysis plays a very important role in the identification and elimination of unnecessary waste in the form of accumulations in the workflow of the production line. The study conducted with the motive of reducing the cycle time of the air tank through bottleneck analysis is successful and achieved significant improvements in the manufacturing of the air tank. The cycle time of the air tank is reduced by 6 hours.

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