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Enhancement in productivity in sheet metal industry through Lean Principles

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ABSTRACT: Today's business growth is totally dependent on the productivity and the customer satisfaction through in-time delivery and services. This Paper addresses the application of lean manufacturing in sheet metal industry. The goal of this research is to investigate how to improve the productivity and in time delivery as expected by customers. In a sheet metal industry, there is always a big challenge for improvement in the productivity of the plant. M/s ABC sheet metal industry manufacturing rim for automotive vehicles have faced the productivity problem from the last three years. A detailed study of production process and the total lead time for manufacturing the rim has been calculated and the result reveals that the present facilities for manufacturing rim is not being used as per their capabilities i.e. nearly half of the production capacity of the plant. The reasons for less utilization of plant capacity are large inventory and WIP. Another reason for less production in the concerned industry was the motivations morale of the employees is very poor which results in lower production rate. This paper illustrate the impact of using Lean manufacturing as a tool to identify the weak areas and improves the lead time for manufacturing process which is being used in rim manufacturing of a sheet metal industry.

Keywords*:* Lean manufacturing, lead time, production rate, productivity.

I. INTRODUCTION

Productivity measures the relationship between outputs & service produced, and inputs that include labor, capital, material & other resources. The main aim of all the management personnel is to decrease labor utilization and maximize equipment utilization to improve productivity.

"Productivity is the quantitative relation between production and the use of available resources to produce them.

Productivity = Utilization × Efficiency (η)

Lean manufacturing have the aspects of improving the productivity by effective utilization of equipment, and man power (means resources). There was many techniques present in the market to improve the plant productivity to remain at competitive position in market. Ahmad et al. stated that lean manufacturing have gone through several evolutions and reached to the state to include cost reduction, quality improvement and performance benchmarking.

Lean manufacturing can be defined as a business system and a generic process management philosophy with a systematic approach to eliminating waste through continuous improvement. [13] Lean Manufacturing focuses on eliminating waste while delivering quality products at the lowest cost to the manufacturer and consumer.

Work study is part of lean manufacturing and used to identify wastages and Work study provides methods of measuring work for determining a performance index or productivity index for an individual or for a group of workers, a department or for an entire plant. The principal objective of work study is to increase productivity & lower unit cost, thus allowing more goods or services to be produced for more people. The average productivity index of a plant would be total standard time produced by all employees divided by the actual hours worked.

$$\text{Productivity index or capacity in numbers} = \frac{S.T}{\text{Actual time}}$$

Work study investigates the work done in an organization & it aims at finding the best & most efficient way of using available resources such as men, material, money & machinery. Work study is actually encompassed by two techniques & these are method study & time study. To illustrate the weak areas in a sheet metal industry, this paper focuses on a case study based on rim used in automotive vehicles. The goal of the case study was to improve lead time for every process being taken a rim fabrication process as well as to identify possible causes of waste.

This research has used calculation of standard compared with observed time, Rated capacity & Bar charts comparing actual & standard time involved & describe the areas which need improvement & how can we proceed in the way of an improvement.

II. LITERATURE REVIEW

Among the subjects that were most frequently studied by researchers are: Work study, lean tools and principles, basics of Toyota Production system (TPS), human resources implications and implementation examples. Work study actually developed by Fredrick w. Taylor in 1880. Work study was first technique to improve productivity. Time study which is part of work study developed by Frederick W. Taylor in about 1880 which he is the first person to use a stopwatch to study and measure work content with his purpose to define "a fair day's work." Time is money and time tells us exactly how much money was used. Besides that, this research was conducted based on Small Medium Industry Development (SMIDP) strategies and encouragement [3].

Gilbreth begin investigation to find the "best way" of performing a given task through analyzing the motions used by his workmen and he easily saw how to make improvements. He also possessed for analyzing work motion situations to enhance their ability for shorter or less fatiguing motions to improve the work environment [11].

Time and Motion Study has become a necessary tool for businesses to be successful today. Time and Motion Study is very important in production control. Now, Offices, Banks, Department Stores, and Hospitals use Motion and Time Study. Offices use it to measure and simplify work in order to reduce costs. Banks use it to help team members reach their sales goals. Frederick W. Taylor used a stopwatch and a clipboard to record the time and findings of his study [2].

Motion and Time study technique can be used widely for variety of research as this technique has been used to study spend time of nurse at hospital.[5] Barnes, R. M in 1949 established a technique for determining the labor costs of acquisition & cataloging work to improve productivity and to decrease lead time. [9]

The ability of the workforce is very helpful to improve productivity. Any increase in productivity will have to be divided between three stakeholders, namely managers/shareholders, workers and customers [8].

A generalized manufacturing system was proposed based on the analysis of the results of literature and industrial surveys & explores the need to adopt the strategic management approach to develop a productivity management model that could integrate with the existing successful quality management model. Identifies the conceptual and strategically elements of productivity and models them under the name "Strategic Productivity Management" (SPM) [10].

The calculated data from continuous observation of activity are used to make point estimates of the average time spent in each category and also the proportion of time occupied by a specified category [1] and investigation of the effect of plant size, plant age and unionization status on implementing key principles of lean manufacturing. Based on their analysis, plant size has an important effect on lean implementations, while effect of unionization and plant age is less than anticipated. The authors also suggest that implementing lean practices such as just in time and total productive maintenance together creates a synergy and makes a significant contribution to operational performance [12].

Overproduction considered as excess of production over demand of products being offered to the market. This leads to excessive inventory in terms of finished and semi-finished goods. Excess production is only relative to a given demand, and insufficient demand is only relative to a given production and thus consider overproduction and under consumption equivalent. Overproduction is the root cause of imbalances, in production sections thereby; the men & machines are either unutilized or being used for over production. It was also concluded that the materials are the major constituent of the products and hence lot of engagement of funds, which need to be controlled for effective functioning. The waiting time shall automatically get reduced creating a 'Pull Production' in place of 'Push Production'. The processes, especially the tooling, need to be improved to facilitate easy and positive changeover. Such controls once put in positions will provide free flow of material including better utilization of available man power. The paper reveals the one of important issue in organizations that is Overproduction-Inventory. The contributions of overproduction items lead towards the excessive unutilized funds including unnarrated inefficiencies due to the wastes [12].

III. CASE STUDY

M/s ABC sheet metal industry Ltd.is the leading industry in the area of rim fabrication for four-wheeler commercial auto vehicles.

Fig. 1. Wheel Rim.

This industry, fabricate the parts through sheet metal process for leading automobile vehicle manufacturing industries like ECEL, ACE, Escorts, VE Commercial Vehicle Ltd. Etc. The rim fabrication process has 12 workstations which are commonly used for all types of rim fabrication process. The present study deals in Rim manufacturing process for Rim Size 14″ × 25″. This production is based on 22 days working spread over period of 8 hours on single shift basis. This average data is more or less consistent in each month that means the averages are sufficient enough to consider it as a base for the study purpose.

Table 1. Actual production month wise.

Months	**Actual production**
May 2012	1620
June 2012	1644
July 2012	1731
August 2012	1864
September 2012	1764
November 2012	1851
Total	**10450**

Average production per month = $\sum_{i=1}^{6}(xi) = \frac{10450}{6}$ = 1742 Nos.

Now, calculate the average production per day = $\frac{\text{Average production per month}}{\text{No. of working days}} = \frac{1742}{22}$ = 79 Nos. (Approx.)

As per installed capacity of plant, the production should be of wheel rims about 120-130 parts per day. But from calculation of above data reveals that the daily average production of wheel rim is just 79 Nos. That is much far away from the situation. Hence, the required area where the improvement is needed is found out.

IV. METHODOLOGY USED

It is a work measurement technique for recording the times and rates of working for the elements of a specified job carried out under specified conditions and for analyzing the data so as to determine the time necessary for carrying out the job at the defined level of performance.

Lean manufacturing technique has been used to identify wastages.

In other words measuring the time through stop watch is called time study. The observed time can be compared standard time through considering rating factor i.e. some numerical value (0-100) allotted to the workers. The work study analyst feels that an operator is working with less effective speed that is being observed than the concept of 80 rating factor was considered as standard.

A. Current situation of the process

For achieve the research objective an experimental study is carried out at M/s ABC sheet metal industry Ltd. The data used for interpretation purpose is based on six month data from May, 2012 to Nov., 2012. The time study at each workstation has been done and the observed timing for each process is shown in Table 2.

Table 2. observed time at each workstation.

Operations	Observed time (O.T) in sec
Blank	240
Die Location Bore	40
1st Draw	50
2nd Draw	50
16 Hole punching	40
Valve Body	30
Bore & 10 hole	50
Lathe	300
Bolt tacking	240
Chemical wash	120
Primer	120
Assembly	140
Total	**1420**

The work study is done through considering work rating factor of 0.8 as discussed, the normal time is calculated. And also the standard time is calculated on the basis of 30% of allowance for drinking water, changing clothes, die setup time etc. The data for Normal time and standard time is shown in Table 3.

After calculating observed time and standard time, the capacity for each work station is calculated. Assume there are 22 working days in month and 8 working hours (28800 sec) in a day. In Table 3, the available time of 28800 sec. was considered. But in actual, like lunch time, Tea break etc. are also considered as allowances. So, the net available time was taken 80 % of available time.

Table 3. Standard time calculations.

Operations	O.T in sec	R.F	N.T in sec =O.T×R.F	S.T in sec = N.T+30%N.T
Blank	240	0.8	192	249.6
Die Location Bore	40	0.8	32	41.6
1st Draw	50	0.8	40	52
2nd Draw	50	0.8	40	52
16 Hole punching	40	0.8	32	41.6
Valve Body	30	0.8	24	31.2
Bore & 10 hole	50	0.8	40	52
Lathe	300	0.8	240	312
Bolt tacking	240	0.8	192	249.6
Chemical wash	120	0.8	96	124.8
Primer	120	0.8	96	124.8
Assembly	140	0.8	112	145.6
Total	**1420**		**1136**	**1476.8**

Table 4. Calculation of capacity for each station.

Operations	S.T. in sec	Available time in sec	Capacity in numbers
Blank	249.6	28800	115.38
Die Location Bore	41.6	28800	692.30
1st Draw	52	28800	553.85
2nd Draw	52	28800	553.85
16 Hole punching	41.6	28800	692.30
Valve Body	31.2	28800	923.07
Bore & 10 hole	52	28800	553.85
Lathe	312	28800	92.30
Bolt tacking	249.6	28800	115.38
Chemical wash	124.8	28800	230.77
Primer	124.8	28800	230.77
Assembly	145.6	28800	197.8
Total	**1476.8**		

On basis of net available time 'D rated capacity' has been calculated as shown in table 5. Figure 2 shows the variation in capacity of production with and without considering the allowance.

Table 5. Calculation of D rated capacity.

Operations	Capacity in numbers	D rated capacity in numbers
Blank	115.38	92.30
Die Location Bore	692.30	553.84
1st Draw	553.85	443.08
2nd Draw	553.85	443.08
16 Hole punching	692.30	553.84
Valve Body	923.07	738.45
Bore & 10 hole	553.85	443.08
Lathe	92.30	73.84
Bolt tacking	115.38	92.30
Chemical wash	230.77	184.61
Primer	230.77	184.61
Assembly	197.8	158.24

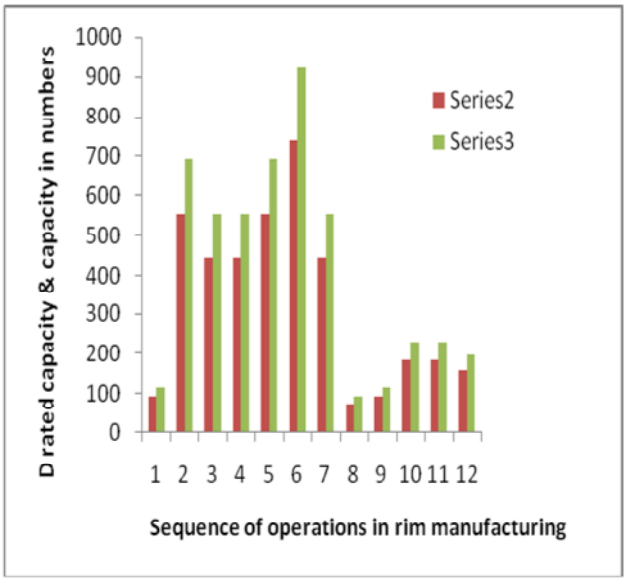

Fig. 2. Bar chart for capacity & D rated capacity.

On basis of net available time rounded value of 'D rated capacity' is shown in table 6. After calculating D rated capacity for all processes and comparing it by proposed production of 120-130 parts per day through Bar chart as shown below in Fig. 3.

Table 6. D rated capacity.

Operations	D rated capacity in numbers
Blank	92
Die Location Bore	554
1st Draw	443
2nd Draw	443
16 Hole punching	554
Valve Body	738
Bore & 10 hole	443
Lathe	74
Bolt tacking	92
Chemical wash	185
Primer	185
Assembly	158

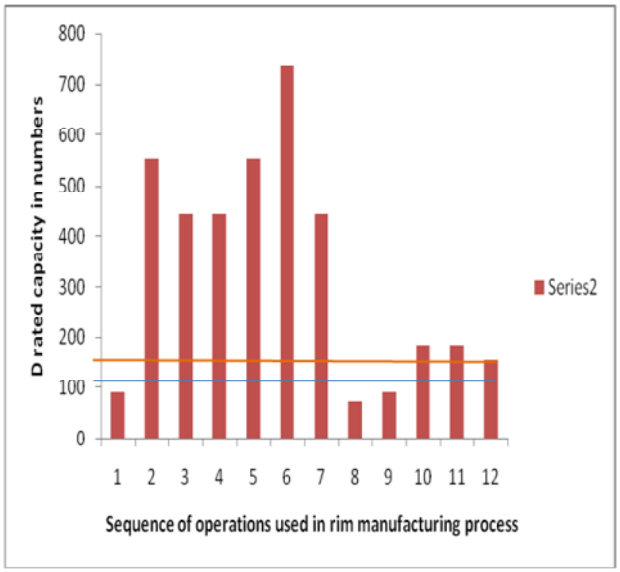

Fig. 3. Comparison of D rated capacity with proposed production.

Now, as per figure 3 it is clear that if a company has got a capacity to produce 110-120 parts per day. But as per chart, there are 3 processes which are below line of 110 Nos. It means, in these 3 processes which are needed to be improve so that productivity can be improved to be remain in competitive market.

B. Recommendations

The Figure 3 depicts that there is clear cut capacity available of 110 Nos. without amending any process or layout or material handling system. The areas which need to be upgraded are clearly shown below the blue line i.e. operation at workstation no. 1, 8, and 9. In case, these operations are improved, the available capacity shall be 175 nos. The various suggestions for improvements are suggested as below:

1. The cutting of blanks out of sheets is being carried out by using Oxy-Acetylene Torch which is slow and will create starvation for subsequent operations. This can be improved by using Plasma Arc Methodology where in the cutting at the edges shall be sharp and also the production nos. will increase tremendously.
2. The punch size at blanking has to be reviewed so-that rework on lathe for bore machining is avoided. Also, while cowling the trimming tool must be added to eliminate shifting of material on to lathe. These two actions shall improve and eliminate working on lathe including productivity improvement as the operation on lathe creates blockage while other operation are starving.
3. The cycle time for bolts tagging is high. Therefore, need to be augmented by using additional set of welding machine.
4. The solution for material handling process was suggested. This problem can be answered by using 500 kg's capacity in jib cranes, also the machines need to be laid out in a sequential manner so as to avoid back freighting of the material
5. Gap between actual and planned production can be filled by motivating the workforce so that the idleness amongst workers this eliminated this can be achieved by categorizing some of incentives so that a worker gets more earning per 8 hours as compared to existing earning this mutual interest between the worker and the management shall lead to congenial atmosphere including the healthy environment.

V. RESULT

The collected data and the observations reveal that the level of production is low and very much in line with non-motivational environment. There is intentional slow down despite the fact that all operations are practically having capacity just double of what is being produced. However, there are three operations which need to be improved along with the suggestions incorporated in this thesis. The implementation of suggestion as a whole shall cut down the wastages at various stations and improve productivity approximately up to 50% (Fig. 4). The material handling has to be dedicated type and tailor made to suite the requirement at the lowest possible cost. Table 7 clearly shows the improvement in monthly production rim assembly.

Table 7. Improved Production.

Months	Improved production
12-Dec	2384
13-Jan	2488
13-Feb	2574
13-Mar	2695
13-Apr	2786
13-May	2795
Total	**15722**

Now, **Improved production per month =**

$\sum_{i-1}^{6}(xi) = \frac{15722}{6}$ = 2620 Nos. (approx.)

Now, Average production per day = $\frac{\text{Production increased per month}}{\text{No.of working days}}$

$= \frac{2620}{22}$ = 119 Nos. (approx.)

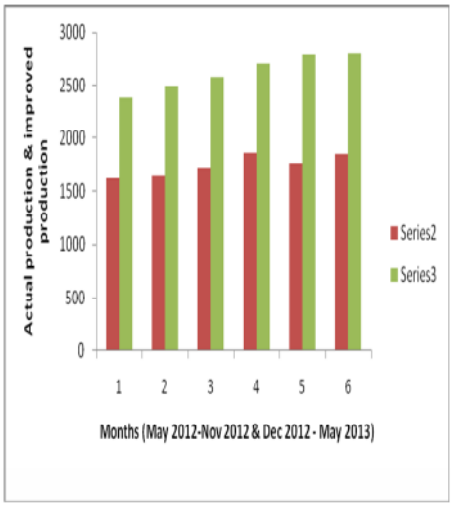

Fig. 4. Comparison of actual production data with improved production data.

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