ISSN: 2348 - 2117

Available Online at www.ijetcr.org

International Journal of Engineering Technology and Computer Research (IJETCR) 2 (1) 2014, 20-23

Productivity Improvement through Lean Manufacturing

Dr. M. P. Singh[1], Dr. Jinesh Kumar Jain[2]

[1]Professor, Jagannath University, Jaipur, [2]Associate Professor Govt. Engineering College, Ajmer

E-mail: mahendra.singh@jagannathuniversity.org

ABSTRACT:

The development and application of thinking "lean" and adopting lean manufacturing will have tremendous savings on resources and yet achieving enhanced productivity to compete in growing global manufacturing sector. In this paper we present the basic understanding of lean manufacturing concept and how it can be implemented in any manufacturing industry for productivity improvement. Our efforts are made to put the concept of lean manufacturing in simple understanding, the tools and techniques used in lean system development and the steps involved in its successful implementation. This paper also presents a result-oriented case study of a leading automobile industry. Industry got benefited in various ways through lean manufacturing application.

Keywords: Lean manufacturing, Productivity improvement, Takt time, Muda (waste)

1. Introduction

The lean manufacturing is a concept developed by Henry Ford in 1920's and first introduced by Toyota Motors in its production system, so it is also been called as "Toyota production system". The concept of lean manufacturing can be defined as a system in which worker and work cell is made flexible and efficient and by their continuous improvement wastes are reduced. Lean manufacturing talks about optimizing and eliminating wastes, rather than minimizing. When we try to minimize one type of waste another will go high. For an example if we try to minimize the machine idle time it can increase the work-in -progress as machines are on over production. At the end of the day the net out come on the organization will be negative. This is why lean promotes elimination and optimization. This may be the core concept of lean manufacturing. An organization which applies lean manufacturing must understand clearly what is a waste? What is meant by improving?

2. Tools and Techniques

To become lean, it is necessary to understand the fact that wastes are always in the system. Lean manufacturing is based on continuous finding and removal of wastes. The four steps involved in implementing lean manufacturing are:

- Identifying the fact about waste
- Analyzing it for root causes
- Solution to root causes
- Application of solutions to achieve objective.

This can repeat like a loop over and over again.

The process mapping is a powerful and simple tool to identify the waste. It includes all activities from development or order inquiry to the point where customer collects goods. Another way is to create overall map with all departments and their interconnectivity within departments. The mapping provides value-added activities and non-value added activities and then to create process map for future. The "*Pareto Analysis*" will indicate the importance of each problem to the system. The "*Ishikawa Diagram*" provides cause effect diagram for root cause-relevance to the system.

Lean manufacturing offers few readymade and well-proven solutions for any industry. A few are JIT (Just-In-Time), work cell, Kanban tooling (communication tool), concept of 5s (standardization techniques), correct tooling, TPM (Total Productive Maintenance) and SMDE (Single Minute Die Exchange). One has to customize these solutions to suit one's organization, keeping in mind lean manufacturing does not start with tools, it starts with lean thinking.

3. Toyota Production System - The Lean Manufacturing

The Toyota production system (TPS) the first of its kind emerged basically from a mutual trust between employees & management and results in employee's satisfaction. The production outcome from these satisfied employees meets customer satisfaction and was based on three principles- JIT, JIDOKA and standardization.

3.1 Just-In-Time

JIT is one of the basic pillars of TPS and eliminates the need for maintaining large inventories (reducing financial

*Corresponding author: Dr. M. P. Singh |

cost & storage cost), thus enabling quick response to changes. It also eliminates the waste that occurs when defects go undetected in manufacturing of large batches. The various tools and techniques are used to put this concept in practice are: -

- *Leveled production* **(**evenly distribution through day/week) - for optimal use of resources.
- *Pull system "Kanban"*- a communication tool (sheet of paper, metallic plate/ wooden board etc.) to physically link preceding process and following process.
- *Continuous flow processing* **-** so that work moves smoothly and on schedule from raw material to machine shops to assembly shop to distributors to dealer and customer.
- *Takt Time* - a time frame for linking the pace of work in every process to the pace of sales in the market.
- *Multiskilled Operators* **-** to handle more than one process to keep work moving in a continuous flow.

3.2 Jidoka

In this principle the work is stopped immediately whenever a problem occurs. This stoppage could be mechanical (automatic) or human operators are equipped with means of stopping production flow. This results in preventing defective items from progressing into subsequent stage of production and thus it prevents waste.

3.3 Standardized Work

It is a tool for maintaining productivity, quality and safety. The three elements structuring standardized work are: *Takt time, working sequence and standard in process stock*. The working sequence is the series of steps for best way to perform a task. Standardized work provides detailed step-by-step guideline for every job in TPS. *Kaizen* is the continuous improvement in that sequence.

4. Implementation Approach

Example:-If in a work cell jobs are arriving at the rate of 6 per day and the operation can process an average of 6.125 jobs per day. (i) What is the current average lead-time for a job? (ii) What is the necessary production rate to achieve the two-day lead-time goal? (iii)How much of a reduction in WIP will result from the 6 % production rate increase?

Solution: -

We know from queuing theory that the average time in the system (manufacturing lead time) is: (i) $t_s=1/(\mu-\lambda)$

Current lead time =1/ (6.125-6) =8 days

(ii) The required production rate:

$\mu=1/t_s + \lambda = 1/2 + 6 = 6.5$ jobs per day

(iii) We also know from queuing theory that the average number of jobs in the system (work-in-process inventory) is:

$N_s = \lambda/ (\mu-\lambda)$

WIP before production rate increase

N_s= 6/ (6.125-6) = 48 jobs

WIP after production rate increase

N_s = 6/ (6.5-6) = 12 jobs

Conclusions

(i) A 6% increase in production rate (from6.125 to 6.5) results in 75% reduction in manufacturing lead time (from 8 to 2).

(ii) A 6% increase in the production rate (from 6.125 to 6.5) results in 75% reduction in work-in-process (from 48 to 12).

5. A case study- Vehicle Manufacturing

Indus Motor Company Ltd. (IMC) was established in Dec. 89 and the plant is situated at Port Qasim, Pakistan. It rolled off the first Toyota corolla car in March, 93. The company has joint venture with Toyota Motor Corporation (TMC) Japan & Toyota Tsusho Corporation (TTC), Japan for manufacturing Toyota vehicles in Pakistan.

Manufacturing Procedure

The process of vehicle manufacturing consists of welding the body parts to form 'shell body'. It is painted in desired colors. Different functional and aesthetic parts are assembled to the painted body for converting into a vehicle. It should be ensured that its look & performance are matching with customer's expectation. The degree of complexity of vehicle production system can be judged from the fact that there are 22 work stations in weld shop, 37 in paint shop and 32 in assembly shop and 8 at final inspection through which every vehicle has to pass prior to reaching to CBU (Completely Built Unit) yard.

Problem

Indus Motor Co. Ltd had plant capacity of producing 10,000-vehicles/ year in single shift. The company wish to produce 3000 units of another model in the same plant thereby an increase in production capacity by 30% became inevitable.

In simple terms the requirement was to increase daily production from 38 vehicle/ days to 50 vehicles/ day thus reducing takt time from 10.5 minutes/ vehicle to 8.5 minutes / vehicle.

Solution 1

One obvious conventional method was to increase the number of work stations which would have resulted in capital investment for providing additional equipment / tools & utilities on one hand and consequent increase of man power on the other hand.

Solution 2

However company decided to increase the capacity by improving productivity.

The Strategy adopted

5.1. Reducing Man Hours through reduction in 3Ms.

3Ms is an abbreviation of 3 Japanese words.
MURI = Over Burden
MUDA = Waste
MURA = Unevenness

5.2. Commitment & challenging the existing work activity

Each department / Section of Indus Motor Co. was asked to examine critically each work activity at every station and eliminate / reduce 3Ms specially the MUDA. As MUDA will reduce, the time spent for doing a process, which will in turn reduce Man-hour/ Vehicle.

The basic philosophy adapted was to challenge every current activity on the work station and pose fundamental questions like, why the activity is necessary. Can it be eliminated altogether? If not, can the time be reduced for doing the same activity? Is this the best method of doing it? Can we merge this activity with some other activity for better result? Can this activity be brought forward? Or can it be done at a later station? etc. All shop in-charges and supervisors of each and every section were clear and committed for their goals and made their activity plans for achieving the same

5.3. Yamazumi chart – *the tool*

The word Yamazumi comprises Yama (Mountain) & Zumi (Building up) meaning "Building up of Mountain". It is a measurement of total time taken for completing all activities resulting in a finished product.

The processing time spent for any process can be divided into two broad categories:

a) Time spent in doing standard job element- value added activities

b) Time spent in Muda (walking, picking, unpacking etc) - non value added activities

5.4. Making of Yamazumi chart

The first step is to carry out a time study of all process elements involved and record the time for standard job element and MUDA. The next step is to put these time elements one on top of the other to get the total time for the finished product. This is what is called a Yamazumi chart. Once this chart is made the value added activities & the non-value added activities are clearly visible for the entire process and concentrated efforts can be made for reducing Muda and rearranging processes so as to achieve required Takt time (demand time interval i.e. available time per product demand).

5.5 A case of trim line in assembly shop

The Trim line in assembly shop has 10 stations and the team member work on both left hand and right hand of the vehicle on the conveyor making a total of 14 work stations Taking a typical example of station No. 2 Left Hand (designated as T2, LH) there are 49 process elements done on this station. A careful time study of each process on this station revealed the following diagram showing time spent on value added and non-value added activities.

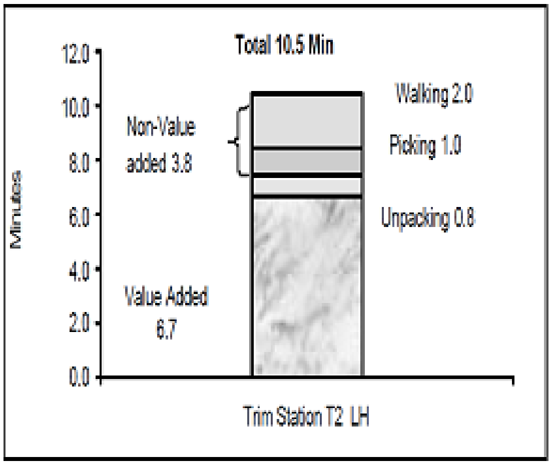

Figure 5.1: Activities on T2, LH station

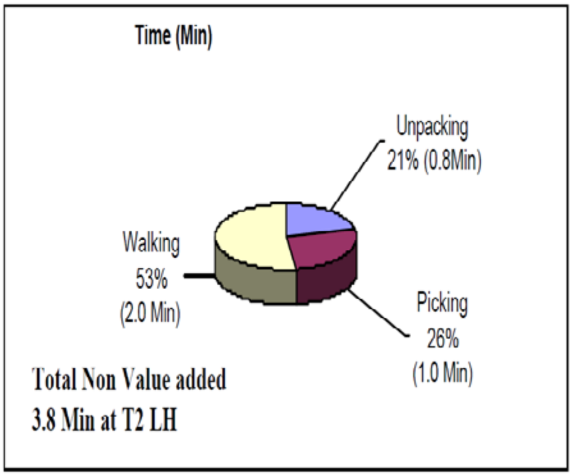

Figure 5.2: Non-value added activities at station T2, LH

The total time of 10.5 min. on this station includes 36% (3.8min.) non-value added activities. A further breakup of non-value added activities indicate that 53% time is spent in walking, 21% in unpacking & 26% in picking the parts as shown.

The similar time study for all the 14 stations of Trim Line is conducted. 41 minutes were spent on non-value added activities, from total trim line operation of 147 min.

5.6 Steps to reduce Muda

5.6.1 Reduction in walking time

51% of non-value added activity consists of walking by worker for picking the part, bringing it to the vehicle, installing it and then repeat cycle for the next part. This movement was reduced by

- **Reduction in picking frequency/ extra movement**

It was observed that workers were in the habit of picking one part at a time from part rack. He was advised and trained to pick as many parts as he can conveniently from the racks and put them in the vehicle and install the parts one after the other. This way, the extra movement got reduced as the picking frequency got reduced from 7 to 3, a total saving of 7 minutes in walking time.

- **Introduction of moveable rack**

For small parts like grommet, washer, screws etc small trolleys were introduced which can be attached with the moving vehicle on conveyor as the vehicle approaches a work station. The simultaneous movement of trolley with vehicle enables workers to access to the small parts without walking. This resulted in saving of one minute in walking time standardization of walking through training to take 2 steps in 1.4 sec provided a saving of 4 minutes in walking time.

5.6.2 Reduction in picking and unpacking time

The following counter measures by company indicate, approach to reduce other non value added times. The use of roller type racks with adjustable shelf height to suit the parts and slight inclination to permit gravity flow of parts provided 5min. saving in pick-up time.

The introduction of these parts with colour coded plastic boxes helped identifying respective model and resulted in reduction of MUDA in pickup operation. This method provided the saving of 2min. in pickup time.

The PPMC (Production planning and material control department) stated supplying the parts in unpacked condition so that unpacking time can be reduced. Introduction of ***Minomi*** (unpacked) supply brought 5 min. saving in unpacking time.

5.7 Improvement observed on trim line

The non-value added time reduced from 41 Minutes to 17 Minutes (a reduction of 58%). The Takt time for each station reduced from 10.5-min/ vehicles to 8.5-min/ vehicle (a reduction of 23%). It made possible to reduce two workstations from trim line (Namely T9LH& T-5 RH) as a result of reducing non-value added time and subsequent re-arrangement of process elements. The consequent increase in production of Trim line was 30% with the same manpower, thereby reducing man-hour per vehicle.

5.8 Yamazumi chart for other processes

The same exercise was conducted for each and every station of weld shop, paint shop, engine shop and PPMC and quality assurance department. Each shop are identified and recognized for 3M's and everywhere when countermeasures were taken the result was reduction in man-hour, and consequent decrease of Takt time. As Toyota Production System is based on "Pull System" the Takt time of the preceding station has to be the same as that of the following station. Consequently the entire plant got operated at 8.5 min. Takt time increasing productivity by 26%.

5.9 Impact of reduction in 3Ms

Product capacity with built-in-quality as per TPS increases by 30%. (3,000 vehicles/year), productivity (man-hour/vehicle) increases by 26% (reduction of 12 man-hrs/vehicle) and work space (sq. meter) saved by 20%.

6. Conclusions

Lean manufacturing is a cost effective tool to enhance productivity by reducing Muda i.e. reduction of waste in a production system leading to reduced Takt time, optimum use of resources and also decrease in work space required.

References

1. M. Mohiyuddin (2000)," productivity enhancement at Indus motor co. Ltd. through focusing on 3m's", Pakistan Institute of Quality Control – (ICQI 2000).
2. M. P. Groover (2006), "Automation Production System, and Computer-Integrated Manufacturing" Second edition, pp.849-851.
3. Aza Badurdeen (2007)," Lean Manufacturing Basics", http://www.leanmanufacturingconcepts.com.
4. N. Gaither, G.Frazier, (2002),"Operation Management" ninth edition.

