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Implementation of Lean Manufacturing Tools in Indian Manufacturing Industries

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A B S T R A C T

In the present era lean concept has a great influence on performance of the manufacturing industries. Lean concept is concerned with reduction of wastages and non-value adding activities. Based on this concept this project is carried out and it is presented in two modules. Module – I is implementation of lean manufacturing tools in the machine shop of a large-scale industry. Various lean manufacturing tools such as VSM, SMED and Kaizen were implemented which shows the reduction in non-value adding activity, modification in workplace and safe working environment. Module –II is related to survey and analysis of implementation aspects of lean manufacturing concept in automotive industries. A survey has been conducted to identify the status of lean practices in Indian automobile industries. A questionnaire for implementation aspects of lean manufacturing tools in the automobile industries has been designed. The data recorded through the survey across the automobile manufacturing industries in India have been analyzed and the results are presented. The reason for low priority towards the lean practices among the industries has been identified and suitable measure has been suggested to address the problem.

Keywords: LMS, Manufacturing, Kaizen, VSM.

1. Introduction

At the end of 1890, Frederick W Taylor became the first to study work management scientifically and distribute the results. His work led to the formalization of time and motion studies and the setting of common standards. Frank Gilbreth then added the concept of breaking work down into elementary time blocks. It was around this time that the first notions of eliminating waste and studying movement began to emerge. In 1910, Henry Ford invented the assembly line for his standardized Ford Model T. Alfred P. Sloan improved on Ford's system when he introduced the concept of assembly line diversity at GM. After the Second World War, Taiichi Ohno and Shingeo Shingo created the Just In Time, Waste Reduction and Pull System concepts for Toyota, which, together with other flow management techniques, resulted in the Toyota Production System (TPS). By the 1950's the Toyota Production System was well into development, and Toyota was beginning its journey to out compete the rest of the world with regard to producing reliable quality cars.

As a company reduces these wastes and strives for single piece flow, many other benefits will follow. Some of these benefits include (1) improved quality and fewer defects (2) reduced inventory (3) less space required to build product, (4) enhancement to overall manufacturing flexibility, (5) identification of future kaizen workshops, (6) ensures a safer work environment and (7) improves employee morale. We will review each of these benefits in more detail:

(1) Improved quality and fewer defects: When batching and lot production are eliminated, there is less opportunity to manufacture defects. Since the batch size will be just 1, there will not be mountains of inventory to count, move, store and pick. Furthermore, single piece flow ensures that if there is a quality problem, we know that the defect has affected only that single part. We do not need to dedicate hours isolating and testing other material in the same production run to determine if it meets quality standards. Of course, if a defect is caught in a single piece flow environment, this should not mean that we do not take the appropriate corrective actions to ensure that the problem will not reoccur. In this case, the manager or supervisor must determine if standard work was followed and if so, what changes need to be made to the standard in order to ensure that the problem will never resurface again.

(2) Reduced Inventory: Implementing single piece flow will require each operation to only produce what is needed by the next operation. When followed properly, the process will eliminate any opportunity to build ahead. Consequently, inventories will not be allowed to build up.

(3) Requires less space: As inventory levels are reduced, less space and manpower will be required to manage (receive, count, stock, store, pick and deliver) it. In addition, single piece flow usually results in manufacturing cells which squeeze machines close together so that a single operator can oversee many pieces of equipment with the least amount of walking motion.

(4) Enhances overall manufacturing flexibility: We know from our value steam maps that the less inventory in a value steam, the shorter the lead-time will be from customer order to product delivery. In a single piece flow environment, since we operate with less inventory, lead-times will also drop,

thereby giving us more time to react to customer orders (unless the strategic decision is made to pass off the lead-time gains to the customer in order to beat competitors).

(5) Makes identifying future Kaizens simpler: We have already discussed that in a single piece flow environment, defects and WIP inventories fall. As this happens, the shop floor will open up and it will become easier to see production problems. For example, if a particular process cannot keep up with takt time and WIP is not allowed to be incurred, it will quickly become apparent to even the casual observer that something is wrong. In this case, it will be easy to decide where to focus the next improvement activity.

(6) Ensures a safer work environment: Less inventory means less clutter, more light in the darkest corners of the factory and the opportunity to better lay out equipment and tools. Also, since manufacturing cells are occupied by a set number of employees who each know their repeating tasks (as defined by standard work), there is less opportunity for unexpected movements, which increase the chances of accidents.

(7) Improves employee morale: Since single piece flow results in production problems being identified and (hopefully) solved right away, team members will receive immediate feedback on their work. This in turn will give everybody more ownership in their production area. Also, provided they lead problem solving efforts by focusing on processes and not individuals, more trust will be gained in managers.

2. Methodology

At first this project work focusses to find out the problems encountered, and examine the degree to which the concepts of lean manufacturing are put into practice within Indian machine tool industries. Certain LMS tools were applied to solve the problems which were occurred. In order to obtain the overall goal of the research, the survey methodology has been followed in second phase. The questionnaire design proceeds in a systematic way with each item. These different topics have then been converted and elaborated as explicit research questions in consultation with academicians, experts from machine tool industries and automotive industry, and most commonly cited lean manufacturing practices from the literature.

This project work is divided in to two modules.

Module-I

I. Implementation of lean manufacturing tools

Some LMS tools like VSM, SMED and KAIZEN are applied in machine shop of a large-scale industry, which is helpful in-

1) Reduction in set-up time.

2) Increase in value addition.

3) Improved workplace layout.

Module-II

II. Survey and analysis of industries

This section is contained questions related to work history and project details. A set of questionnaires is prepared for this section. Here an effort is made to find out the degree of adoption of lean manufacturing in the Indian automotive industries. Data were collected via a questionnaire survey throughout the India as given in appendix-1. This method seems to be the best data collection technique, enables a larger amount of data to be gathered in a short period of time. The samples of organizations were obtained from the directory of Indian industries. They were randomly selected from those with complete information and contact details. 150 manufacturers were identified and questionnaires were distributed to them using postal mail. The questionnaires were addressed to the General Managers or Managing Directors of the companies. They were considered to be the best addressees because they were likely to be the thought leaders in charge of lean manufacturing.

Table 1. Crusher hammer shop data (present system)

Machine/shop/process Name	Number of Machines	Number of operators/ machines	Setup (min.) per machine setup
1) Raw material inspection	01	02	2.0
2) Marking	02	02	3.0
3) Drill machine	02	03	6.5
4) Hardening	02	03	3.0
5) Water cooling	01	02	0.00
6) Final inspection	01	02	2.0

Table 2. Process time (min.) for each machine/process /facility (present system)

Process	Process time (min.)
R.M. inspection	03/30 piece
Marking	08/30 piece
Drilling(3 stages)	15/05 piece
Hardening	02/30 piece
Cooling	10/30 piece
Inspection	10/30 piece

Table 3. Cycle time (min) for each machine/facility (present system)

Process	R.M. inspection	Marking	Drilling (3 stages)	Hardening	Cooling	Final Inspection
01) Cycle time	6.13	8.1	90.21	2.1	10	10.06
02) Process time	3	8	90	2	10	10
03) Set-up time	2	3	6.5	3	00	2
04) No. of facilities	1	2	2	2	2	2
05) Batch size	30	30	30	30	30	30

3. Result and Discussions

LMS was successfully applied to improve productivity of crusher hammer manufacturing. This was possible through the application of LM tools. SMED was used for the reduction of setup time of drill machine. Another LM tool, Kaizen, was used to make design and work methods change of the machine components and work elements involved in setup of the drill machine to reduce the setup time in multiple stages (continuous improvement).

LMS was successfully employed to improve crusher hammer manufacturing productivity or output. The LMS tools; such as value stream mapping, single minute exchange of die, and Kaizen were employed to reduce the setup time of drill machine. The improvement, especially in drill machine was achieved through Kaizen (continuous improvement) targeting design and work method changes. The specific innovative design changes or improvements made in the drill machine to reduce the setup time included the application of work table modification. Other benefits were obtained through reduction of work-in-process inventory, which in turn reduced the shop floor congestion and improved workplace safety.

The data recorded through the survey across the core machine tool manufacturers have been analyzed, and the results are presented. The results show that the status of lean implementation in the machine tool sector is still in infant stage. The reasons for low priority towards lean practices among the industries have been identified, and suitable measures have been suggested to address the problems. This will further assist the machine tool industries to gauge their level of leanness and will serve as a foundation for future research.

The success of the LMS application can be attributed in particular to: 1) top management support for LMS philosophy and a commitment for continuous improvement through providing continuous employment, job assurance, and resources; 2) formation of LMS team with members from functional departments and appointing lean coordinator and lean associate coordinate for future continuity of the LMS program; 3) provision of necessary orientation and training and 4) collection of relevant and accurate functional (operational) data for the selected products. It should be recognized that LMS as a philosophy or concept provides the required environment to reduce waste. However, the design and work methods improvement can only be achieved through systematic engineering analysis that includes work design and work method engineering. For making meaningful improvements, often new approach and innovations are required. To obtain the full cooperation of work force for the continuous improvement, the top management must follow the policy of continuous employment and adapt progressive approach towards business to provide job security to the workforce.

Table 4. Profile of the Respondent Companies

Respondent Companies		
a) Size of the Companies	**No. of Companies**	**Percent**
Small and Medium Enterprises	39	65
Large Organizations	21	35
Total	**60**	**100**
b) Adopted Lean Manufacturing (Number of years)		
< 4 years	30	50
4-8 years	24	40
> 8 years	6	10
Total	**60**	**100**

Table 5. Benefits and Status of LM principles implemented

Sr. No	Benefits of LMS	Percentage

1	**Financial Saving Gained**	**94.3**
2	Reduced manufacturing cost	90.8
3	**Productivity improvement**	**87.1**
4	Reduced Manufacturing time	84.2
5	**Reduction in process cost gained**	**80.9**
6	Assembly line layout	76.4
7	**Reduced Takt time**	**74.7**
8	Decreased inventory	72.6
9	**Profit gain increases**	**64.1**
10	Increased Quality Gain	61.5
11	**Improved response time gain**	**57.1**
12	Increased multi-skilled work force	54.9
13	**Less rework gain**	**51.2**
14	Improved flexibility	42.3
15	**Capacity increase in current facility**	**40.6**
16	Transportation & material handling reduction	43.5
17	**Reduction in floor space utilization**	**36.8**
18	Improved 5 S score	34.3
19	**Reduced labour work force**	**32.9**

Sr No	**LM Principles**	**Percentage**
1	Waste reduction	88.5
2	**Continuous improvements**	**81.5**
3	Standardization	80.2
4	**Supplier-customer relationship**	**79.5**
5	Teaching And learning	74.1
6	**Tools and techniques**	**62.6**
7	Managing product development	40.1
8	**Toyata production System**	**34.5**
9	Integrated management policy	31.2
10	**Work culture**	**16.3**

4. Conclusion

In summary, the conclusions obtained from this module-I are the following:

- LMS was successfully applied to improve productivity of crusher hammer plate manufacturing.
- LMS tools such as SMED and Kaizen (continuous improvement) were employed to reduce setup time of the drill machine from 6.5 to 3.28 min, an improvement of 100 %.
- VSM, a LMS tool, revealed that the value addition percentage (%VA) of the crusher hammer manufacturing shop was around 18.34 %. VSM (future state) projected the value addition percentage to be around 34.04 % after the implementation of all the improvement projects, the increment of 186 % from the current level, which resulted from the setup time reduction of drill machine.
- Several innovative Kaizen (continuous improvement) design change or improvements were proposed to reduce the setup time of the drill machine. The Kaizen design included

a) Provide scale at length and width wise on work table of drill machine for quicker adjustments – kaizen Design -1

b) Temporary box type arrangement is to be provided on worktable to avoid clamping (as size of hammer plate is fixed and production is in bulk.) – Kaizen Design - 2

- Additional benefits were observed through a reduction of WIP inventory and floor space utilization resulting in improved plant layout. This in turn would enhance safety at the workplace.
- Several Kaizen target changes in work methods were proposed that included providing scale at both sides of drill machine worktable, keeping tool box near the machine, providing separate tool sets for operators and using pneumatic tools instead of manual tools

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