PRODUCTIVITY IMPROVEMENT THROUGH LEAN DEPLOYMENT & WORK STUDY METHODS

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Abstract

The objective of this paper is to present an overview on a new combined methodology for the efficient improvement in productivity with the help of various Work Study Methods associated with Lean Manufacturing Principles & Tools. Lean manufacturing tools are one of the most influential & most effective methodologies for eliminating wastes (MUDA), controlling quality, and improving overall performance of any machine, system or process in any industry with the complete assurance of large annual profit margins. This prescriptive paper proposes genuine solutions & concepts for implementing Work Study Methods and deploying associated lean manufacturing tools in any enterprise or industry, covering the technical, engineering, and manufacturing aspects as well as the business etiquette affairs. Lean Manufacturing together with Work Study Methods, being the most sophisticated & vast area of studies has a huge scope for implementation & deployment of their very own concepts.

Keywords: *5S, Wastes (Muda), Time & Method Study, Setup Time Reduction (SUR), Standardized Work (SDW).*

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1. INTRODUCTION

Productivity has been generally defined as the ratio of an extent of output to the unit of all of the resources used to produce this output. Productivity usually deviates from production. Production concerns with an increment in output over a given span of time; productivity is concerned with the ratio of output to an input. Putting in another way, improving productivity has to do with how effectively people combine different resources to manufacture parts and services others dream to purchase. With the correct choices, improved production, higher values and elevated incomes can be accomplished for every hour worked. [1]

With rapid increase in demand of production, manufacturing industries need to increase their potentials in production & effectiveness to compete against their competitors. At the same time, the production process has to be ready with the ability to have abated costs with higher proficiency. Hence the route to simplify the problem regarding the production is of paramount importance. There are many ways i.e. Standardize Work (SDW), Setup Reduction (SUR), Cycle Time Reduction, Waste Elimination, etc. to solve the problems concerning & governing productivity.

Considering the inclination towards a customer-focused environment while facing fierce juxtapositions, majority of manufacturers are implementing Work Study Methods along with lean manufacturing tools to help eliminate wastes and increase proficiencies rather than depending on conventional processes and procedures [8]. According to many researchers, using Lean Tools is the best way to improve productivity by eliminating or reducing time consuming actions which generally do not contribute in actual production. It is a way by which one can reduce the cost of manufacturing & increase productivity, which also increases annual profitability of the industry. [2]

1.1 Role of Lean Tools in Improving Productivity

The basic definition of Lean Manufacturing can be stated as, a perspective to manufacturing that searches for an opportunity to reduce the operation time of processes, increase maneuverability, and improve the corresponding attributes. The primary concept behind Lean manufacturing is optimizing customer significance while minimizing wastes, thereby achieving manufacturing excellence through the creation of more value with fewer or absolutely no capital investments. [4]

Specific set of tools used in/for Lean Manufacturing, which comprises together a complete methodology and which are interdependent on each other forming a sophisticated yet effective system are knows as Lean Tools. They play vital role in any productivity improvement event as they have a very high rate of success & also long lasting improved effect.

1.2 Role of Work Study in Improving Productivity

Work Study is the systematic methodology of carrying out different yet related activities such as to improve the efficient use of resources and to set up standards of performance & quality for the activities to be carried out.

In simple language, it may be defined as the analysis of a job for the sheer purpose of finding the subsequent method of doing it and also determining the required standard time to perform it by the selected or given method. [9]

Work Study generally is classified in two areas: Method study (Motion study) and Time study (Work measurement).

2. LEAN TOOLS

Lean tools have not been derived or proposed in one single day. They have been derived from the research of many people throughout the history. As they are why very complex & interdependent on each other and one can find similarities in one another.

Fig -1: Critical Lean Tools

Currently in practice, there are approximately 25 Lean Tools, out of which, these five tools are considered to be the most critical Lean Tools of all, as shown in above figure. [8]

2.1 Bottleneck Analysis

A point of concourse in a machine or system that arises when work load gathers at a point in the system more hastily than that specific point can hope to maintain them. The intricacies fetched about by the bottleneck often make a queue and a longer overall cycle time. By definition, a bottleneck is a phenomenon where the competency of a complete system or line is restricted or limited by a single or limited number of components or resources & analysis of such event is called as Bottleneck Analysis.

Hence, Bottleneck Analysis is nothing but the identification of which part/machine of the manufacturing process/line limits the overall output and focuses on improvement the performance of that part/machine of the process/line. [5]

Bottleneck Analysis is usually done along with the Time Study Method. The system on which the analysis is required to be done is first selected. Then in the form of 'Daily Analysis', 'Minute to Minute Analysis; or 'Macro Second Study Analysis' the entire process is carried out along with the guidance of Time Study Methods.

An example of Minute to Minute Bottleneck Analysis is as shown in the figure below

Time (Min)			Down Time (Min)	Remark
7.00	To	7.34	34.00	Operator Absent
7.34	To	7.44	10.00	Machine Setting and Parameters Checking
7.44	To	7.51	7.00	Single job produced, Lab testing for quality
7.51	To	8.10	19.00	Power Loss
8.10	To	8.19	9.00	Operator Absent, M/c stopped due to power loss
8.19	To	8.27		27 no's produced
8.27	To	8.32	5.00	Machine Stopped, Point problem
1.24	To	1.26	2.00	Tool Change
1.26	To	1.30	4.00	Operator Away from machine, m/c Stopped
1.30	To	1.45		Tea break
1.45	To	1.50	10.00	Operator Away from machine, m/c Stopped
1.50	To	3.09		263 no's produced
3.09	To	3.30	21.00	M/c Stopped, Shift Change
Total Time: 510.0			Down Time: 175	
Run time = 335 minutes (Total time - Down time)				

Fig -2: Example of Bottleneck Analysis Sheet

2.2 Wastes (MUDA)

Anything in the manufacturing process that does not add value to the product from the customer's perspective is known as Waste. In simple Language, It is nothing but any process for which the customer does not pay the company.

There are 7 most Deadly Wastes in common –

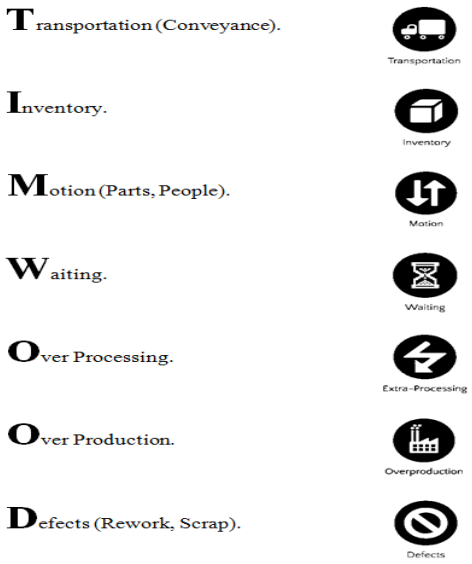

Fig -3: Seven Deadly Wastes

1. **Transportation** - The unnecessary movements of operator, products or components from one place to another result in this waste. Unnecessary transport more commonly occurs together with product damages, lost parts and systems, which are related with movements. [3]
2. **Inventory** - Inventory is the quantity of materials in stores, which are required to manufacture a job. When they are not used, they take up valuable storage space, may become useless, which cannot be used for more important goods. [3]
3. **Motion** - This waste comprises of all unnecessary movements occur when operator is moving around his work area and as a result of this; his time & efforts are wasted. All kinds of unnecessary motion may be caused by improper working standard practices, un-optimized process design or work space layout. [3]
4. **Waiting** - If operators, machine, system or materials of the production process are delayed by any reason, production time is wasted, the productivity is decreased & the cost of production will be increased.
5. **Over Processing** - It can also mean manufacturing the products of a larger quality than required. This can also be result of not checking what the customers' real requirements are. [3]
6. **Over Production** - It arises when the manufacturer is producing more products than the customer really asks for. This is the worst kind of waste, as it generally creates other kinds of wastes. It increases rework factor, material storage, processing, holding & waiting, as well as transportation & unnecessary motion. [3]
7. **Defects (Rework, Scrap)** - Rework is required when products and components are defective or damaged. Defects are caused by bad manufacturing processes (caused by human or machine errors). In worst case scenario the items have to be discarded.

In these 7 wastes, 'Over Production' & 'Inventory' are observed to be very similar to one another & hence, in modern Lean Methodology, 'Inventory' is often replaced by '**Inspection**'.

Also, one more waste is being added to these 7 deadly wastes as this waste is also observed to be of great importance, and that is '**Unutilized Skill**'.

2.3 5S

An established methodology procreating in Japan that, when implemented, mitigates the waste of resources and work area in spite of increment in manufacturing & operational proficiency. The 5S elements when translated in English are Sort, Set-in-Order, Shine, Standardize & Sustain and are applied in various industries to achieve lean manufacturing & to ultimately improve productivity. [5]

Idea of 5S can be explained by following 5 Steps -

- **Sort:** Completely Sort out & classify that which item is required and/or not required in the work area.
- **Set in Order:** Arrange items in required order that are important so that they are ready to find & easy to use.
- **Shine:** Clean the work area, tools, machine & equipments on a continuous basis in order to identify defects& maintain standards.
- **Standardize:** Ensure standard & uniform procedures and methods throughout the operation to promote changeover.
- **Sustain:** Stay to the regulations to maintain the standard & continue to improve every day. [5][6]

2.4 Standardized Work (SDW)

Standardized work is a collection and implementation of the best practices known to that point. It includes what is mandatory to begin the procedure and the completed state of the same. Standard Work is the sequential method for defining the best practices and ensuring that every operator is strictly following them to endow the value to the customers. Because improvements in safety, quality, productivity & profitability will arise from time to time & the standardized work is to be updated via work instructions document, training, and practice. These are the methodologies that improve quality, safety, productivity & profitability.

Basically, standardized work consists of four elements:

- Takt time, which is the rate at which the products must be manufactured in order to meet customer demand on time.
- The accurate work sequence in which the operator performs tasks within takt time.
- The corresponding inventory, including jobs in machines, required to maintain the process operation smoothly.
- The dexterity of the operator & the maneuverability of the machine or system.

2.4.1 Steps Involved in Standardized Work

1. Identify and define the best system that bestows a quality result, consistently.
2. Document the steps for performing the best practice, and make it visual using combination of pictures and text.
3. Place it at each work station where this process is being performed by the operator.
4. Train the operators to do the tasks as defined in the Standard Operating Procedure.

Standardized work adds regimentation to the abidance, an element that is frequently neglected but essential for lean to take foundation.

3. WORK STUDY METHODS

In order to understand the work study methods, we need to understand the importance of method study and that of time study. 'Method study' (sometimes also called Work Method Design) is mostly used to improve the method of doing work. When applied to existing products, method study aims to allocate better methods of manufacturing the jobs that are safe, effective, & economical, require mitigated human effort, and need smaller make-ready time. The better method involves the optimum use of best materials and appropriate manpower so that work is performed in well-organized manner leading to increased resource utilization, optimized quality and appeased costs.

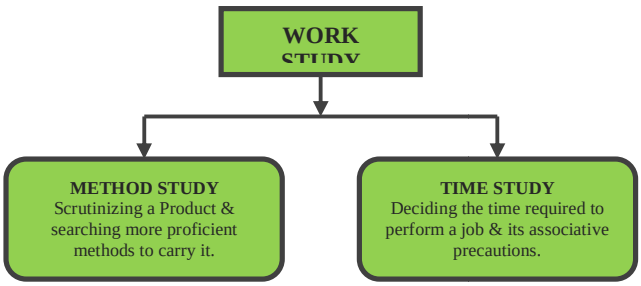

Fig -4: Work Study Methods

It can therefore be stated that through 'Method study' one can have a systematic way of developing human resource ascendancy, providing elevated machine and equipment use, and making economical use of raw materials. 'Time study', however, provides the standard required time, that is the time needed by worker to complete a job by the standard method. By the application of method study and time study together with Lean Tools, any industry can thus achieve greater output at less cost and of better quality, and hence can easily achieve higher productivity. [9]

3.1 Method Study (Work Method Design)

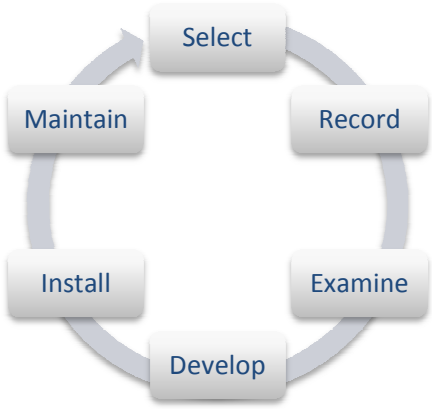

Fig -5: Method Study Procedure

As seen earlier, Method study focuses to achieve the better method of doing work, and for this reason method study is sometimes called Work Method Design.
The following steps depict the procedure for creating a method study.

1. Select (the work to be studied).
2. Record (all relevant information about that work).
3. Examine (the recorded information).
4. Develop (an improved way of doing things).
5. Install (the new method as standard practice)
6. Maintain (the new standard proactive).

3.2 Time Study (Work Measurement)

Work measurement refers to the estimation of standard time for an activity that is the time specific for completing one job by using the predicted method. Standard time can be defined as the time utilized by an average experienced skillful operator for the job with provisions for delays beyond the operator's control.
A work has to be measured for the following reasons:

- To identify and eliminate missing or ineffective time.
- To install standard times for performance & quality measurement.
- To measure performance against original expectations.
- To set manufacturing & operating objectives.

Time study can be simply defined as a technique to estimate the time to be allowed to a qualified and well-trained worker working at a normal pace to complete a specified task by using specified method.

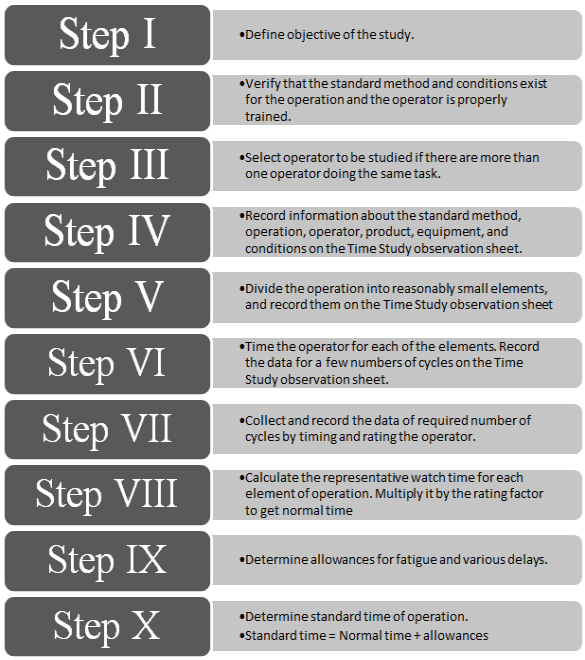

Fig -6: Time Study Procedure

4. SETUP TIME REDUCTION (SUR)

Setup is a set of activities to be prepared for the next part or process, Whereas, Setup Time is the total elapsed time from completion of the last good part from the previous setup to the completion of the first good part from the new setup. Setup Time Reduction or Change-over Time Reduction is defined as the efficient reduction time to change from the last item of the previous order to the first good item of the next order in order to obtain increased productivity. [11]

Setup includes preparation, replacement, location and adjustment activities. In setup reduction process, internal setup activities require an inactive (shut down) process, meaning that no jobs can be manufactured while the setup activity is taking place & external setup activities may be done while the machine is operational. By definition, all activities performed while the machine is not producing parts are considered internal activities. And, all the setup related activities that are performed while the machine is producing good parts (either the previous order or the new order) are considered external activities. Incredible reductions in total setup time have been realized simply by making internal activities external activities. [10]

4.1 Need for Setup Time Reduction

Today's manufacturing and business environments are reaching a point that competition for survival and market share is an obligation. Tracking the global economy will show that being good is not sufficient, therefore every organization really endeavor for transcendence if want to remain in the competition.

Why Setup Reduction?
Simply -

"Equipment and the operator are occupied* but *there is NO output"

Setup Time Reduction is one of the best methods to increase efficiency of the overall plant and thereby improving the profitability.

- Setup time reduction improves the equipment availability, increasing the total capacity & results in:
  - Better utilization of operator's time.
  - Better utilization of resources & capital cost.
  - Reduced capital investment.

- Reduced setup time makes smaller batch sizes possible, without the economic penalty, resulting in reduced:
  - Overall lead times.
  - Inventory & storage space needs.
  - Reject rates.

Setup Reduction allows batch size reduction, which is critical for continuous flow manufacturing & improves manufacturing flexibility.

The following five-step approach to setup reduction may be used to achieve efficient results –

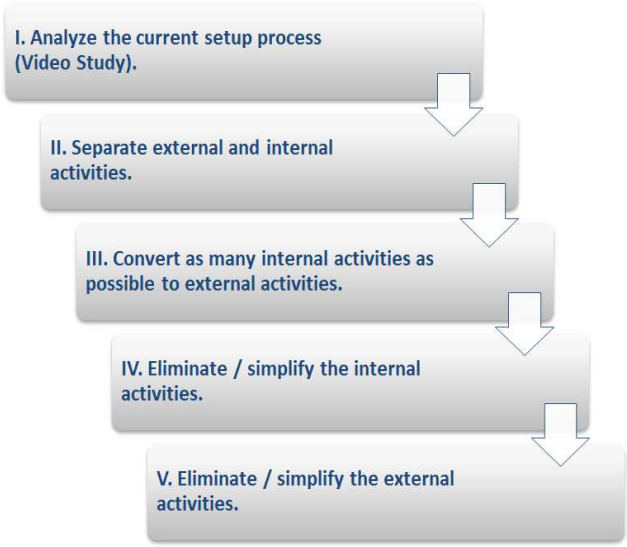

Fig -7: Five Step Approach to SUR

5. SUMMARY

In summary, with the help of systematic study of all the critical lean tools stated above along with efficient work study methods, the required results of improving productivity can be achieved in limited or very less resources in return.

In order to select target for the improvement, method study can firstly be done to obtain accurate results about the system which is crucial for defining the problem. After the corresponding target has been selected, Bottleneck Analysis is the best option to narrow down the area of problem. Once that is done, advanced time study methods are to be implemented to find out detailed problems present in the system.

Once the industry gets hold of the detailed problems, they can be categorized in substantial groups in order to maintain their integrity & so that, efficient solution on a particular problem can easily be obtained. With Critical Lean tools stated above, problems can be efficiently classified in corresponding area and those tools can be applied one by one to get long lasting results along with improved productivity as well as profit margin.

CONCLUSIONS

From the above paper & Studies, it can be concluded that, Critical lean tools when effectively combined with Work Study Methods, a unique leaner system can be formed which will be the universal solution for any type of industry having any sort of problem regarding the productivity. If implemented in proper order, 100% positive results are assured.

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