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A LITERATURE REVIEW ON LEAN MANUFACTURING IN TEXTILE INDUSTRIES

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Abstract

The circumstances and climate condition for a textile industry is totally different than all other manufacturing industries. Due to technology enhancement the garment manufacturing has been migrating from the traditional to technological. Even though the labor cost in India is cheaper than developed countries; though the textile industries adopting new machinery, automation and more flexible tools to upgrade themselves. At the same time the maintenance strategies and lean manufacturing gets changed according to methodologies involved. Since demand is increasing, the company also looking for higher production. Keeping all this in mind the Lean manufacturing tools are reviewed from renowned research papers and a concise summary is being gathered here in this research paper for ready reckoner.
Key Words: Garment Industries, Lean Manufacturing, Performance Improvement

I. HISTORY OF LEAN

During II world war, the economic condition of Japan was heavily destroyed. Due to this there was scarcity of fund resulting in limiting access to corporate finance. In this situation, neither Toyota was able to set up a mass production system like their American counterparts, nor it was possible to layoff the employees to reduce their cost due to legislation. Anyhow Toyota had to devise a new system for reducing costs to sustain in the market. So they decided to produce a small batch of products which would reduce inventories; it means they would need less capital to produce the same product. But this is obstructed by the practical difficulty of changing tools and production lines frequently. To cope with this problem they started making multipurpose tooling systems in their machines and trained their employees in changeover time reduction methods. At the same time, Toyota realized that investing in people is more important than investing in bigger size machinery and continues employee training throughout the organization. This motivates all employees and they are more open to the improvement process and everyone started giving their input to the company.

In this way, short production runs started by Toyota became a benefit rather than a burden, as it was able to respond much more rapidly to changes in demand by quickly switching production from one model to another (Drew, Blair and Stefan, 2004). Toyota didn't depend on the economies of scale production like American companies. It rather developed a culture, organization and operating system that relentlessly pursued the elimination of waste, variability and inflexibility. To achieve this, it focused its operating system on responding to demand and nothing else. This in turn means it has to be flexible; when there are changes in demand, the operating system is a stable workforce that is required to be much more skilled and much more flexible than those in most mass production systems. Over time, all these elements were consolidated into a new approach to operations that formed the basis of lean or Toyota Production System.

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II. DEFINITION OF LEAN

The popular definition of Lean Manufacturing and the Toyota Production Systemusually consists of the following (Wilson, 2009).

- It is a comprehensive set of techniques which when combined allows you to reduce and eliminate the wastes. This will make the company leaner, more flexible and more responsive by reducing waste.
- Lean is the systematic approach to identifying and eliminating waste through continuous improvement by flowing the product or service at the pull of your customer in pursuit of perfection (Nash, Poling and Ward, 2006).

According to (Drew et al., 2004) the lean operating system consists of thefollowing:

- A lean operating system follows certain principles to deliver value to the customer while minimizing all forms of loss.
- Each value stream within the operating system must be optimized individually from end to end.
- Lean tools and techniques are applied selectively to eliminate the three sources of loss: waste, variability and inflexibility.

Thus the organization who wants to implement lean should have strong customer focus, should be willing to remove wastes from the processes they operate on daily basis and should have the motivation of growth and survival.

III. KIND OF WASTES

According to David Magee, (Magee, 2007) different kinds of wastes in a process can be categorized in following categories. These wastes reduce production efficiency, quality of work as well as increase production lead time.

1. Overproduction – Producing items more than required at given point of timei.e. producing items without actual orders creating the excess of inventories which needs excess staffs, storage area as well as transportation etc.
2. Waiting – Workers waiting for raw material, the machine or information etc. isknown as waiting and is the waste of productive time. The waiting can occur in various ways for example; due to unmatched worker/machine performance, machine breakdowns, lack of work knowledge, stock outs etc.
3. Unnecessary Transport – Carrying of work in process (WIP) a long distance,insufficient transport, moving material from one place to another place is known as the unnecessary transport.
4. Over processing – Working on a product more than the actual requirements are termed as over processing. The over processing may be due to improper tools or improper procedures etc. The over processing is the waste of time and machineswhich does not add any value to the final product.
5. Excess Raw Material - This includes excess raw material, WIP, or finishedgoods causing longer lead times, obsolescence, damaged goods, transportation and storage costs, and delay. Also, the extra inventory hides problems such as production imbalances, late deliveries from suppliers, defects, equipment downtime, and long setup times.
6. Unnecessary Movement – Any wasted motion that the workers have to performduring their work is termed as unnecessary movement. For example movement during searching for tools, shifting WIP etc.
7. Defects – Defects in the processed parts is termed as waste. Repairing defectiveparts or producing defective parts or replacing the parts due to poor quality etc. is the waste of time and effort.
8. Unused Employee Creativity – Loosing of getting better ideas, improvement,skills and learning opportunities by avoiding the presence of employee is termed as unused employee creativity (Liker, 2003).

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IV. CONTINUOUS IMPROVEMENT

According to (Gersten and Riss, 2002) Continuous improvement (CI) can be defined as the planned, organized and systematic process of ongoing, incremental and company-wide change of existing practices aimed at improving company performance. Activities and behaviors that facilitate and enable the development of CI include problem-solving, plan-do-check-act (PDCA) and other CI tools, policy deployment, cross-functional teams, a formal CI planning and management group, and formal systems for evaluating CI activities. Successful CI implementation involves not only the training and development of employees in the use of tools and processes, but also the establishment of a learning environment conducive to future continuous learning.

The short description of PDCA cycle is given below
Plan: Identify an opportunity and plan for change.

Do: Implement the change on a small scale.

Check: Use data to analyze the results of the change and determine whether it made adifference.

Act: If the change was successful, implement it on a wider scale and continuouslyassess the results. If the change did not work, begin the cycle again.
Thus continuous improvement is an ongoing and never ending process; it measures only the achievements gained from the application of one process over the existing. So while selecting the continuous improvement plan one should concentrate on the area which needs more attention and which adds more value to our products. There are seven different kinds of continuous improvement tools (Larson, 2003) they can be described as follows. The use of these tools varies from case to case depending on the requirement of the process to be monitored.

Pareto Diagram: The Pareto diagram is a graphical overview of the process problems,in ranking order from the most frequent, down to the least frequent, in descending order from left to right. Thus, the Pareto diagram illustrates the frequency of fault types. Using a Pareto, one can decide which fault is the most serious or most frequent offender.
Fishbone Diagram: A framework used to identify potential root causes leading to poorquality.

Check Sheet: A check sheet is a structured, prepared form for collecting and analyzingdata. This is a generic tool that can be adapted for a wide variety of purposes.
Histogram: A graph of variable data providing a pictorial view of the distribution ofdata around a desired target value.

Stratification: A method of sorting data to identify whether defects are the result of aspecial cause, such as an individual employee or specific machine.
Scatter Diagram: A graph used to display the effect of changes in one input variableon the output of an operation.

Charting: A graph that tracks the performance of an operation over time, usually usedto monitor the effectiveness of improvement programs.

V. JUST IN TIME

Just in time is an integrated set of activities designed to achieve high volume production using the minimal inventories of raw materials, work in process and finished goods. Just in time is also based on the logic that nothing will be produced until it is needed (Shivanand, 2006).
Just-in-time manufacturing is a Japanese management philosophy applied in manufacturing. It involves having the right items with the right quality and quantity in the right place at the right time. The ability to manage inventory (which often accountsfor as much as 80 percent of product cost) to coincide with market demand or changing product specifications can substantially boost profits and improve a manufacturer's competitive position by reducing inventories and waste. In general, Just in Time (JIT) helps to optimize company resources like capital, equipment, and labor. The goal of JIT is the total elimination of waste in the manufacturing process. Although JIT system is applied mostly to manufacturing environment, the concepts are not limited to this area of business only. The philosophy of JIT is a continuous improvement that puts emphasis on prevention rather than correction, and demands a companywide focus on quality. The requirement of JIT is that equipment, resources and labor are made available only in the amount required and

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at the time required to do the work. It is based on producing only the necessary units in the necessary quantities at the necessary time by bringing production rates exactly in line with market demand. In short, JIT means making what the market wants, when it wants, by using a minimum of facilities, equipment, materials, and human resources (Roy, 2005).

VI. TOTAL PRODUCTIVE MAINTENANCE

Machine breakdown is one of the major headaches for people related to production. The reliability of the equipment on the shop floor is very important because if any one of the machines is down the entire shop floor productivity may be nil. The tool that takes care of these sudden breakdowns and awakes maintenance as well as production workers to minimize these unplanned breakdowns is called total productive maintenance. Total Productive Maintenance (TPM) is a maintenance program, which involves a newly defined concept for maintaining plants and equipment. The goal of the TPM program is to increase production, increase employee morale and job satisfaction. (Bisen and Srivastava, 2009, p. 175)
TPM is set of tools, which when implemented in an organization as a whole gives the best utilization of machines with least disruption of production. The set of tools are called pillars of TPM and they are shortly described here and illustrated in a TPM diagram (Figure 2).

i. 5S

The first pillar of TPM is called 5S, which organize and cleans work place; this helps to make problems visible and attracts the attentions of everyone. Brief description of 5S elements are as follows:
Sort: The first step in making things cleaned up and organized.
Set In Order: Organize, identify and arrange everything in a work area.
Shine: Regular cleaning and maintenance.
Standardize: Make it easy to maintain, simplify and standardize.
Sustain: Maintain what has been achieved.

ii. AUTONOMOUS MAINTENANCE

This is about the involvement of production workers in the day to day general maintenance of machines like cleaning, lubricating etc. which saves the time of skilled maintenance person at the same time the production workers are made more responsible to their machines.

iii. KAIZEN

Kaizen is for small improvements, but carried out on a continual basis and involve all people in the organization. Kaizen requires no or little investment. The principle behind is that "a very large number of small improvements are more effective in an organizational environment than a few improvements of large value." This pillar is aimed at reducing losses in the workplace that affect our efficiencies (Kumar, 2008).

iv. PLANNED MAINTENANCE

It addresses the proactive approach of maintenance activities. This involves four types of maintenance namely preventive maintenance, breakdown maintenance, corrective maintenance, and maintenance prevention.

v. QUALITY MAINTENANCE

It is aimed towards customer delight through the highest quality and defect free manufacturing. In this system, one has to take care of parts which affect product quality and try to eliminate or modify them to give customer superior quality.

vi. TRAINING

Employees should be trained such that they can analyze the root cause of the problem. General know how of the problem is not sufficient rather they should be able to know why the problem is occurring and how to eliminate it. For this employee need continuous training, ultimately; the entire employee should be multi-skilled and should solve the problem in their area by themselves.

vii. OFFICE TPM

This tool is about increasing the efficiencies in office (administrative) activities. This tool works the problems like communication issues, data retrieval processes, management information systems, office equipment losses, up to date information about inventories etc.

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viii. SAFETY HEALTH AND ENVIRONMENT (SHE)

In this area, the focus is to create a safe workplace and a surrounding area that would not be damaged by our process or procedures. This pillar will play an active role in each of the other pillars on a regular basis. Safe work environment means accident free, fire less and it should not damage the health of workers.

ix. WORK STANDARDIZATION

A very important principle of waste reduction is the standardization of work. Standardized work basically ensures that each job is organized and carried out in the same manner; irrespective of the people working on it. In this way if the work is standardized the same quality output will be received even if the worker is changed in process. At Toyota, every worker follows the same processing steps all the time. Thisincludes the time needed to finish a job, the order of steps to follow for each job, and the parts on hand. By doing this one ensures that line balancing is achieved, unwanted work in process inventory is minimized and non value added activities are reduced. A tool that is used to standardize work is called takt time.

x. WASTE REDUCTION TECHNIQUES

Some of the waste reduction tools include zero defects, setup time reduction, and line balancing. The goal of zero defects is to ensure that products are fault free all the way, through continuous improvement of the manufacturing process (Karlsson and Ahlstrom 1996). Human beings almost invariably will make errors. When errors are made and are not caught then defective parts will appear at the end of the process. However, if the errors can be prevented before they happen then defective parts can be avoided. One of the tools that the zero defect principle uses is Poka Yoke. Poka-Yoke, which was developed by Shingo, is an autonomous defect control system that is put on a machine that inspects all parts to make sure that there are zero defects. The goal of Poka-Yoke is to observe the defective parts at the source, detect the cause of the defect, and to avoid moving the defective part to the next workstation (Feld, 2000).

xi. SINGLE MINUTE EXCHANGE OF DIE (SMED)

Single Minute Exchange of Die (SMED) is another technique of waste reduction. During 1950's Ohno devised this system; and was able to reduce the die changing time from 1 day to three minutes (Womack, Jones and Ross, 1990). The basic idea of SMED is to reduce the setup time on a machine. There are two types of setups: internal and external. Internal setup activities are those that can be carried out only when the machine is stopped while external setup activities are those that can be done during machining. The idea is to move as many activities as possible from internal to external (Feld, 2000). Once all activities are identified than the next step is to try to simplify these activities (e.g. standardize setup, use fewer bolts). By reducing the setup time many benefits can be realized. First, die-changing specialists are not needed. Second, inventory can be reduced by producing small batches and more variety of product mix can be run.
Line balancing is considered a great weapon against waste, especially the wasted time of workers. The idea is to make every workstation produce the right volume of work that is sent to upstream workstations without any stoppage (Mid-America Manufacturing Technology Center Press Release, 2000). This will guarantee that each workstation is working in a synchronized manner, neither faster nor slower than other workstations.

VII. METHOD STUDY

Method study focuses on how a task can (should) be accomplished. Whether controlling a machine or making or assembling components, how a task is done makes a difference in performance, safety, and quality. Using knowledge from ergonomics and methods analysis, methods engineers are charged with ensuring quality and quantity standards are achieved efficiently and safely. Methods analysis and related techniques are useful in office environments as well as in the factory. Methods techniques are used to analyze the following (Heizer et al., 2000):

- Movement of individuals or material. Analysis for this is performed using flow diagrams and process charts with varying amounts of detail.
- Activity of human and machine and crew activity. Analysis for this is performed using activity charts (also known as man-machine charts and crew charts).
- Body movement (primarily arms and hands). Analysis for this is performed using micro-motion charts.

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VIII. LABOR STANDARDS AND WORK MEASUREMENTS

Effective operations management requires meaningful standards that can help a firm todetermine the following (Heizer et al., 2000)

1. Amount of labor contribution for any product (the labor cost).
2. Staffing needs (how many people it will take to meet required production).
3. Cost and time estimates prior to production (to assist in a variety of decisions, from cost estimates to make or buy decisions).
4. Crew size and work balance (who does what in a group activity or on an assembly line).
5. Expected production (so that both manager and worker know what constitutes a fair day's work).
6. Basis of wage-incentive plan (what provides a reasonable incentive).
7. Efficiency of employees and supervision (a standard is necessary against which to determine efficiency).

Properly set labor standards represent the amount of time that it should take an average employee to perform specific job activities under normal working conditions. The labor standards are set in by historical experience, time studies, predetermined time standards and work sampling.

IX. HISTORICAL EXPERIENCE

Labor standards can be estimated based on historical experience i.e. how many labor hours were used to do a similar task when it was done last time. Based upon this experience the new time will be fixed for any new operation or works. Historical standards have the advantage of being relatively easy and inexpensive to obtain. They are usually available from employee time cards or production records. However, they are not objective, and we do not know their accuracy, whether they represent a reasonable or poor work pace, and whether unusual occurrences are included. Because their variables are unknown, their use is not recommended. Instead, time studies, predetermined time standards and work sampling are preferred (Heizer et al., 2000).

X. TIME STUDIES

The classical stopwatch study, or time study, originally proposed by Federic W. Taylor in 1881, is still the most widely used time study method. The time study procedure involves the timing of a sample of worker's performance and using it to set a standard. A trained and experienced person can establish a standard by following these eight steps (Heizer et al., 2000).

1. Define the task to be studied (after methods analysis has been conducted).
2. Divide the task into precise elements (parts of a task that often takes no more than a few seconds).
3. Decide how many times to measure the task (the number of cycles of samples needed).
4. Record elemental times and rating of performance.
5. Compute the average observed cycle time. The average observed cycle time is the arithmetic mean of the times for each element measured, adjusted for unusual influence for each element:
6. Determine performance rating and then compute the normal time for each element.
   Normal Time = (average observed cycle time) x (performance rating factor).
7. Add the normal times for each element to develop a total normal time for each task.
8. Compute the standard time. This adjustment to the total normal time provides allowances such as personal needs, unavoidable work delays and worker fatigue.

Standard Time=(Total Normal Time)/(1-Allowance Factor)

Personal time allowances are often established in the range of 4% to 7% of total time, depending upon nearness to rest rooms, water fountains, and other facilities. Delay allowances are often set as a result of the actual studies of the delay that occurs. Fatigue allowances are based on our growing knowledge of human energy expenditure under various physical and environmental conditions. The major two disadvantages of this method are; first they require a trained staff of analysts and secondly the labor standards cannot be set before tasks are actually performed.

XI. PREDETERMINED TIME STANDARDS

Predetermined time standards divide manual work into small basic elements that already have established times (based on very large samples of workers). To estimate the time for a particular task, the time factors for each basic element of that task are added together. Developing a comprehensive system of predetermined time standards would be prohibitively expensive for any

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given firm. Consequently, a number of systems are commercially available. The most common predetermined time standard is methods time measurement (MTM), which is the product of the MTM association (Heizer et al., 2000).
Predetermined time standards are an outgrowth of basic motions called therblings. The term "therblig" was coined by Frank Gilbreth. Therbligs include such activities as select, grasp, position, assemble, reach, hold, rest and inspect. These activities are stated in terms of time measurement units (TMUs), which are each equal to only 0.00001 hour or 0.0006 minutes. MTM values for various therbligs are specified with the help of detailed tables.
Predetermined time standards have several advantages over direct time studies. First, they may be established in laboratory environment, where the procedure will not upset actual production activities. Second, because the standard can be set before a task is actually performed, it can be used for planning. Third, no performance ratings are necessary. Fourth, unions tend to accept this method as fair means of setting standards. Finally, predetermined time standards are particularly effective in firms that do substantial numbers of studies of similar tasks.

XII. WORK SAMPLING

It is an estimate of the percentage of time that a worker spends on particular work by using random sampling of various workers. This can be conducted by the following procedures (Heizer et al., 2000).

1. Take a preliminary sample to obtain an estimate of the parameter value (such as percent of time worker is busy).
2. Compute the sample size required.
3. Prepare a schedule for observing the worker at appropriate times. The concept of random numbers is used to provide for random observation.
4. Observe and record worker activities.
5. Determine how workers spend their time (usually as percentage).

XIII. LAYOUT DESIGN

Layout is one of the key decisions that determine the long-run efficiency of operations. Layout has numerous strategic implications because it establishes an organization's competitive priorities in regard to the capacity, processes, flexibility and cost as well as quality of work life, customer contact and image. An effective layout can help an organization to achieve a strategy that supports differentiation, low cost, or response (Heizer et al., 2000, p. 336). The layout must consider how to achieve the following:

1. Higher utilization of space, equipment, and people.
2. Improved flow of information, material or people.
3. Improved employee morale and safer working conditions.
4. Improved customer/client interaction.
5. Flexibility (whatever the layout is now, it will need to change).

XIV. ASSEMBLY LINE BALANCING

Line balancing is usually undertaken to minimize imbalance between machines or personnel while meeting a required output from the line. The production rate is indicated as cycle time to produce one unit of the product, the optimum utilization of work force depends on the basis of output norms. The actual output of the individual may be different from the output norms. The time to operate the system, hence, keeps varying. It is, therefore, necessary to group certain activities to workstations to the tune of maximum of cycle time at each work station. The assembly line needs to balance so that there is minimum waiting of the line due to different operation time at each workstation. The sequencing is therefore, not only the allocation of men and machines to operating activities, but also the optimal utilization of facilities by the proper balancing of the assembly line (Sharma, 2009).

XV. CONCLUSION

This research paper describe lean manufacturing tools and techniques for waste reduction and efficiency enhancement. Literature defines lean manufacturing, describes some lean tools (most relevant to this research), work standardization and assembly line balancing tools. The lean tools selected consist of cellular manufacturing, single piece flow, just in time (pull production), work standardization methods, continuous improvement process, and some other waste reduction tools. The chapter ends with the work standardization process by time studies, layout design and assembly line balancing methods.Lean is a powerful tool, when adopted it can create superior financial and operational results. But in many cases, the confusion about how to start lean, from where to begin is also a problem for new practitioners. In some cases, the company tries to implement lean but it does not give effective results and stops in-between. All these are due to lack of clarity before implementing lean and lack of top management commitment. So to avoid the chances of failure one has to prepare in advance for the outcomes of the lean and should involve all employees on improvement programs. Lean is not just about the implementation of tools but also the development of its employees to adopt these tools. So, regular training and upgrading of employee skill is the most important factor for the success of lean.

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