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Review Article

A Review on Lean Tools & Techniques: Continuous Improvement in Industry

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Abstract

Lean system also known as Toyota production system and comprises of different tools and technique which provide basis for Continuous Improvement. All small &medium scale industry facing certain problem resulting in shortage of production & quality issues .Correct application of right tool at right time and at right place creates wonder in many industries. Starting with time and motion study which gives basic idea about process time and provide clues for value stream mapping. TPM is one of most useful tool which improve effectiveness and efficiency of equipment.5S and Kaizen are commonly used technique collaboration with TPM, which provide ground level improvements. Collective application of these discussed tool help organization to achieve better position in competitive market where main focus is on reduction of lead time and improving quality.

Keywords: *Lean tools, Time and motion study, TPM, 5's, Kaizen, SMED*

Introduction

In Today's Industrial Environment huge losses/wastage occur in the manufacturing shop floor. This waste is due to operators, maintenance problem, Tooling problems and non-availability of components in time, non-value added activity in manufacturing etc. Other forms of waste includes idle machines, labour absenteeism, break down machine, rejected parts etc. are all examples of waste. The qualities related to waste are of significant importance as to the company in terms of time, material and the reputation of the company in the market.

Productivity is the relationship between output and input. It means adding value to input to enhance value of output. Productivity can be achieved by enhancing the value-added content of products/services, or by decreasing the unit cost of production, or a combination of both It is a total concept that addresses the key elements of competition, for example is innovation, cost, quality and deliver (Erlendsson, J. 2006, Mayank Dev Singh *et al*, 2012).

There are different techniques of waste reduction and performance enhancement like Just in Time (JIT), Total Quality Management (TQM), Total Productive Maintenance (TPM), Kaizen etc. JIT is a strategy for manage the inventory in which raw materials and components are delivered from the vendor or supplier immediately before they are needed in the manufacturing plant. Kaizen is Japanese technique for "improvement" or"change for the better" refers to philosophy or practices that focus upon continuous improvement of processes in manufacturing, engineering and business management (Rajesh Gautam *et al*, 2012).

Frequent machine breakdowns, low plant availability, increased rejection are a great threat to increase operating cost and lower productivity. Maintenance has become more challenging in the current dynamic business environment. Zero oriented concepts such as zero tolerance for waste, defects, break down and zero accidents become a pre-requisite in the manufacturing and assembly industry (Christie, 2007). In this situation, a revolutionary concept of TPM has been adopted in many industries across the world to address the above said problems (Ranteshwar Singh *et al*, 2012).

An efficient layout may also contribute in the cycle time reduction in production, work-in-progress, idle times, number of bottlenecks or material handling times and to the increase in the production output, with obvious implications on productivity (R. D. Vaidya *et al*, 2013).

Technique to Solve Different problem

Quick changeover is also known as setup reduction which focuses on eliminating or reducing non value added activities during the setup.

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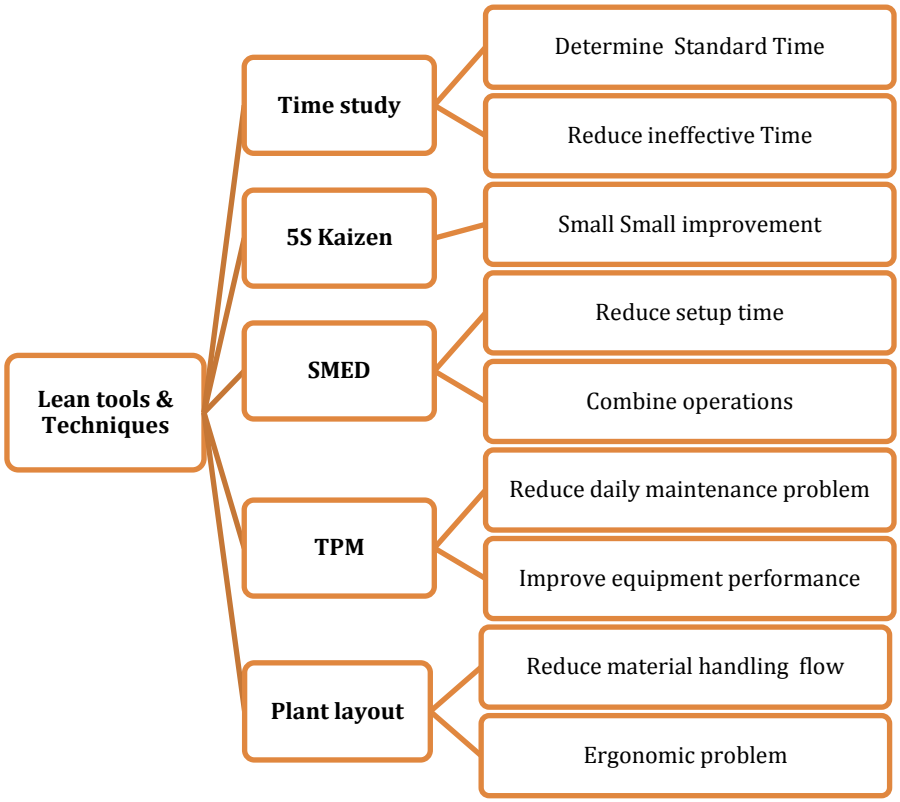

Fig 1: Different Lean Tools & its applications

The need of SMED is mandatory due to increased demand for variable products and reduced product life cycles. SMED also known as "quick changeover," or "rapid changeover", this method can be applied any time equipment is "changed" from one physical state to another It helps the company to keep reduced inventory and effective utilization of the equipment. SMED analysis has to be started up with detailed process map and time study. It needs analyzing everything that happens during the changeover to understand the possibilities of activities that can be moved outside the changeover window (Arun Abraham *et al*, 2012).

Different Tools & Techniques use in this Paper

A) Work study

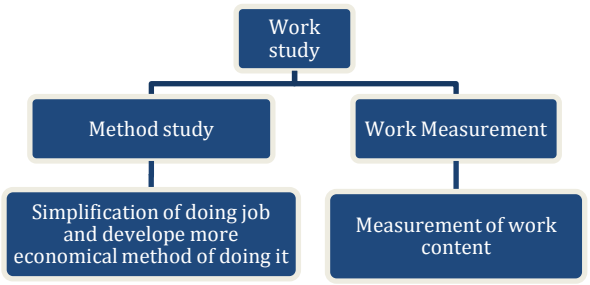

Fig 2: Work study procedure

Work study widely known for years "Time & Motion study". " Work study is the systematic examination of the method of carrying on activities so as to improve the effective use of resources & reduce the ineffective time, to improve the productivity."

Time study

"Time study is defined as a work measurement technique for recording the times & rates of working for the element of a specified job carried out under specified conditions ,and for analyzing the data so as to obtain the time necessary for carrying out the job at a defined level of performance."(ILO).

There are several techniques of time study:

- Stopwatch time study
- Work Sampling method
- Predetermined Time Standard (PTS)

Motion study, according to Ralph M. Barnes (2001) Frank and Lillian M. Gilbreth are known as the parents of motion study. Gilbreth begin investigation to find the "best way" of performing a given task trough analyzing the motions used by his workmen and he easily sawhow 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. The research included the elimination of all useless motions and the reduction of those remaining motions. The elimination of this unwanted waste known as work simplification. (Nirav Patel *et al*, 2015)

In motion study, Rearranging the elements of work to reduce the work content and we can simplify the operation by moving part.

Some charts are used in Motion study are

- Operation process chart
- Flow process chart
- Multiple activity chart
- Travel chart
- Two handed process chart

B) 5S- Kaizen

Kaizen is a Japanese word that has become common in many western companies. The word says that small improvement of process in a continuous way of the standard flow of process & work. **Kai means change and Zen means for the better "change for the better"**(Rajesh Gautam *et al*, 2012).

The cycle of kaizen activity can be defined as

- Standardize an operation and activities.
- Measure the standardized operation (find cycle time and amount of in-process inventory)
- Innovate to meet requirements and increase productivity
- Standardize the new, improved operations
- Continue cycle

Kaizen is also known as the Deming cycle, or PDCA (Plan do check & Act). Other Techniques used in conjunction with PDCA include 5 Whys, like root cause and fishbone diagram Continuing series of Kaizen activities are needed to achieve product performance and reduce the cost. Combining target and Kaizen costing is a powerful approach for the construction company by assuring value for the customer at a low but profitable price (Rajesh Gautam *et al*, 2012).

Kaizen helps to

- Reduce the human efforts
- Increase the productivity
- Reduce the strain of operator
- Reduction the manufacturing cost
- Improve the quality (Rajesh Gautam *et al*, 2012)

5S is also known as Japanese word, to implemented, modify the waste of resources and work area to improve productivity and profitability.

Sort

The 1stS, Sort, calls for the elimination of unnecessary items that have collected around work areas. As debris and unused objects build up, productivity often takes a turn for the worse. In unproductive workspaces, frustrations mount when workers find that they are unable to satisfactorily finish the task at hand. Therefore, it is vital to implement a workplace sorting system. The effective visual method of identifying unneeded items is called "Red Tagging.

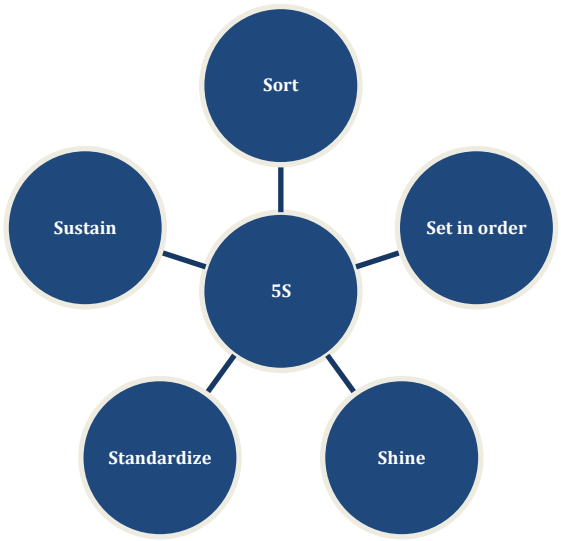

Fig 3: 5S Techniques

Set in order

Now that your workplace has been sorted, it is time to implement a more comprehensive system of organization. While sorting is an effective method, used by it, it is only a preliminary measure. Set in Order (Seiton) focuses on effective storage and organization methods, with the end goal of developing an environment that resists clutter and aids long-term productivity.

Shine

Once you have eliminated the clutter in your work area, it is important to thoroughly clean that area and the equipment in it. Leaks, squeals and vibrations involving clean equipment can often be easily detected, but a| dirty workplace tends to be distracting and equipment faults go unnoticed. Clean workplace conditions are also important to employee health, morale, and safety.

Standardize

Cleaning and organization systems implemented without established standards tend to lose effectiveness with time. Allow your employees to participate in the development of standards that improve workplace conditions. Ask for feedback as you find the best way to balance employee morale with production concerns.

Sustain

This is by far the most difficult S to implement and achieve. People tend to resist change and even the

most well-structured 5S plan will fail if not constantly reinforced. Fortunately, there are effective methods of sustaining positive growth (Dinesh B. Shinde *et al*, 2014).

C) Single Minute Exchange Die [SMED]

The Single-Minute Exchange of Die (SMED) concept took its step at Toyo Kogyo's Mazda plant in Hiroshima, Japan when its author, Shigeo Shingo conducted a production efficiency improvement study in 1950.

The SMED system is a method that make possible to perform equipment setup and changeover operations under 10 minutes, and is also used as an element of Total Productive Maintenance – TPM.

SMED is one of the Lean production method for reducing waste in manufacturing process. It provides rapid and efficient way of converting a manufacturing process from running the next product. The phrase "single minute" does not mean that all changeovers and startups should take only one minute, but they should take less than 10 minutes. The need for SMED and quick changeover programs is more popular now than ever due to increased demand for product variability, reduced product life cycles and the need to significantly reduce inventories. SMED and quick changeover are the practice of reducing the time it takes to change a line or machine from running one product to the next (Yash Dave, 2012).

Process of SMED

Fig 4: SMED Procedure

Types of setup

i). External Setup - Setup done while the machine is running, e.g., tools and dies preparation before setup or returning of tools and die after setup is done.
ii). Internal Setup - setup done while the machine is off, e.g., installation or replacement of new die.(Yashwant R. Mali, 2012)

Techniques for SMED Implementation

The eight techniques for implementing SMED (Silvia Pellegrini, 2013) (Shingo 1985):

- Separate internal from external setup operations
- Convert internal to external setup
- Standardize function ,not shape
- Eliminate fasteners altogether
- Use intermediate jigs
  - Adopt parallel operations
- Eliminate adjustments
- Mechanization

D) Total Productive Maintenance [TPM]

Total Productive Maintenance (TPM) is an alternative approach to equipment maintenance that seeks to achieve zero breakdowns and zero defects. TPM is a unique Japanese philosophy, which has been developed based on the Productive Maintenance concepts and methodologies. Total Productive Maintenance is an innovative approach to maintenance that optimizes equipment effectiveness, eliminates breakdowns and promotes autonomous maintenance by operators through day-to-day activities involving total workforce. TPM stands for "Total Productive Maintenance" and builds a close relationship between Maintenance and productivity, showing how good care of equipment will result in higher Productivity.

TPM was introduced to achieve the following objectives

- Avoid waste in a quickly changing economic environment
- Reduce costs
- Continues improvement
- Produce goods without reducing product quality

TPM Goals

a) Improving equipment effectiveness

b) Down time and Speed losses.
c) Defects or Quality losses.
d) Involving operators in daily maintenance
e) Repair level.
f) Preventive level.
g) Improvement level.
h) Improving maintenance.
i) Efficiency and effectiveness.
j) Educating and training personnel.

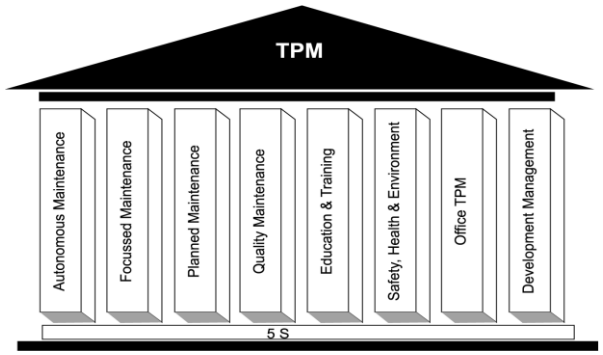

Fig 5: TPM Pillars

TPM Pillars & its Analysis

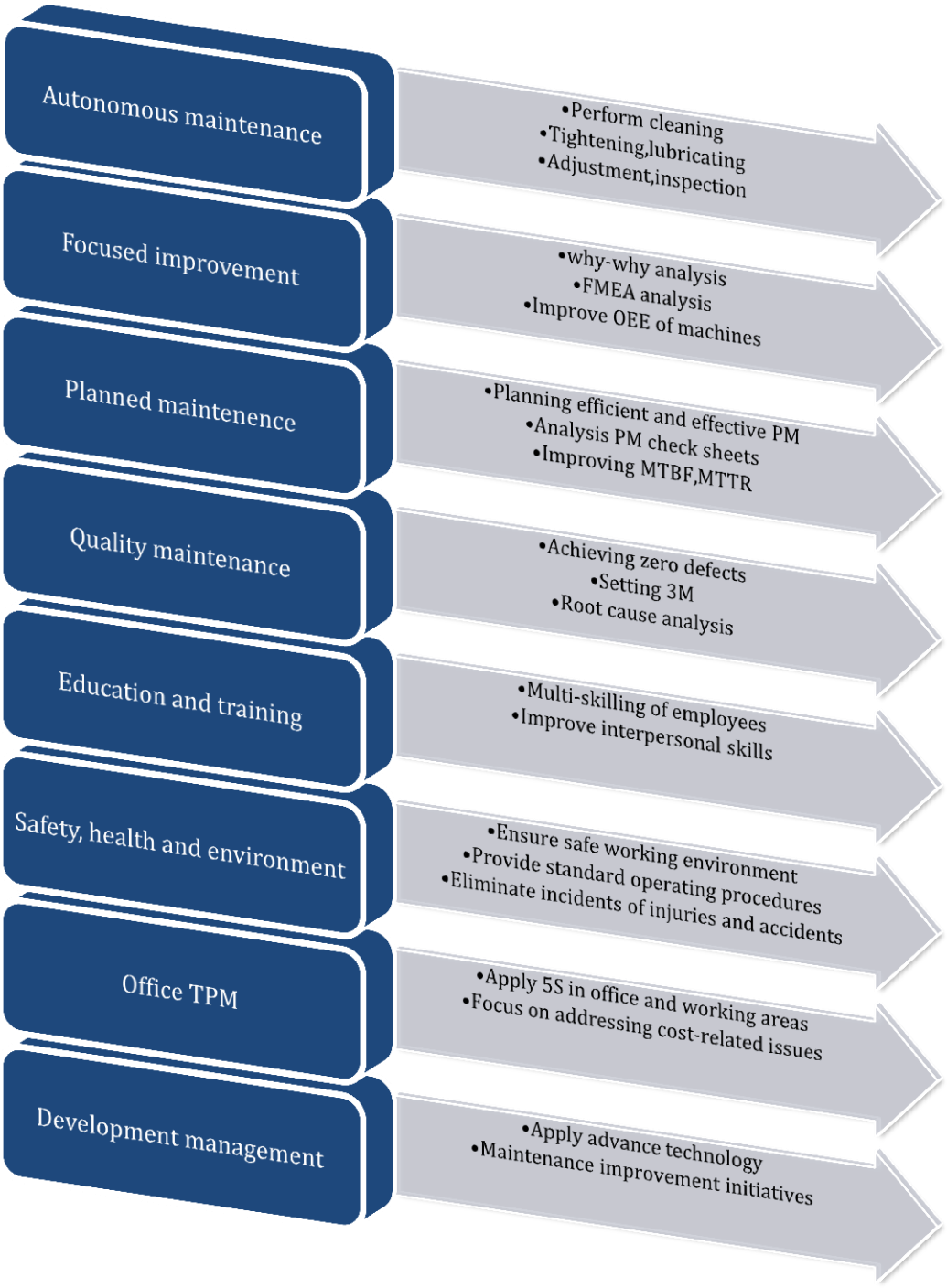

Fig 6: TPM Pillars analysis

Different Researcher Review based on Lean Tools & Techniques

Title	Author/ Year	Journal/ Conference	Tools & Techniques	Result & Summary
A Review on Improvement of Workflow and Productivity through Application of Time and Motion Study Technique	Ankit Vekariya, Ashutosh Kumar **2014**	IJSRD	Work study	1) The most important tool for any industry is work study to determine the standard time to increases the production rate. 2)Time and motion study technique is useful for investigation of the process.
Productivity improvement through Lean development & Work study methods	Prathamesh P. Kulkarni, Sagar S. Kshire, Kailas V. Chandrate **2014**	IJRET	7 muda ,5S,Time & method study	1) Lean manufacturing together with work study being most sophisticated and large area of research & large scope for improvement. 2) five lean tools are used- setup reduction, bottleneck analysis, waste (MUDA), 5S, Standard work.
The Use of Work Study Techniques in Optimizing Manufacturing Plant Maintenance Processes: an Investigation into a Fertilizer Manufacturing Company in Zimbabwe	Mutombozana Tapiwa, Mugwindii Kumbirayi, Chikuku Tauyanase **2013**	International Journal of Science and Research (IJSR)	Work study& Ergonomics	1) Fluctuations in availability& productivitycan only be attributed to major breakdown or recurrent minor ones. 2) To create optimum model to improve OEE.
To Improve Productivity By Using Work Study & Design A Fixture In Small Scale Industry	Mayank Dev Singh **2012**	IJTARME	Plant layout & time study	1) PRO-E software is used for model testing and develop new model. 2) The improvement was successfully implemented and Design the fixtures time is reduced to 1 hour for making product.
Reduction in product cycle time in bearing manufacturing company	Nirav patel **2015**	International Journal of Engineering Research and General Science	poka yoke	1) Time study method is useful for cycle time reduction of any new product development. 2) To identify the suitable rating factors and allowances using time study & calculate the OEE.
Enhancing Overall Equipment Effectiveness of HMC Machines Through TPM and 5S Techniques in a Manufacturing Company	Mohammedasif Mulla, Ramesh C.G **2014**	International Journal on Mechanical Engineering and Robotics (IJMER)	TPM,5S	1) The root causes analysis is used in HMC machines & Fishbone diagram helps to identify the causes for bottleneck problem on Machine.
Kaizen Implementation in an Industry in India : A Case Study	Rajesh Gautam, Sushil Kumar, Dr. Sultan Singh **2012**	IJRMET	Kaizen	1) The takt time is important to meet the customer demand at minimum cost & Clubbing of operation is required to meet the same target & improve quality.
Implementation of Kobetsu Kaizen pillar in Improving Overall Equipment Effectiveness of Machine	FirdosJahan Khan, Quazi T. Z. **2014**	International Journal of Engineering science & Research Technology	Kaizen	1) KK Pillar looks into all the losses, analyses the losses using various QC tools and comes up with suggestions that need to be implemented to reduce recurring losses.
Optimizing Overall Equipment Effectiveness of high precision SPM using TPM tools.	G.TamiIzharasi, S.Katthiresan **2012**	IJCTT	TPM, Fishbone diagram	1) Interviews, reviewing documentation and historical records, machine break down registers, direct and participatory observations were used as data collection methods during the research. 2) Brainstorming Analysis, On-Field Analysis, Cause and Effect Diagram & Pareto Analysis techniques are also useful.
A Total Productive Maintenance (TPM) Approach To Improve Overall Equipment Efficiency	Hemant Singh Rajput1, Pratesh Jayaswal **2012**	International Journal of Modern Engineering Research (IJMER)	TPM	1) To achieve zero breakdowns and zero defects,TPM approach is very helpful. 2) Bottleneck equipment is identified and was decided for TPM approach.
Total Productive Maintenance (TPM) Implementation in a Machine Shop: A Case Study	Ranteshwr Singh, Ashish M Gohil, Dhaval B Shah, Sanjay Desai **2012**	Science Direct	5S,Kaizen	1) Success of TPM depends on various pillars like 5-S, Jishu Hozen, Planned Maintenance, Quality maintenance, Kaizen, Office TPM and Safety, Health & Environment. 2) Still world class TPM implementation is possible with continual support at all the levels along with the supply of necessary resources.

Overall Equipment Efficiency and Productivity of a News Paper Printing Machine of a Daily News Paper Company - A Case Study	Pradeep Kumar, Raviraj Shetty, Lewlyn L.R. Rodrigues **2014**	International Journal of Engineering Practical Research (IJEPR)	TPM	Consists of observations and calculations of highly visible measures of performance such as, Overall Equipment Effectiveness (OEE), Total Productivity (TP), Downtime reasons and its frequency of occurrence and Variation of OEE over a period of thirty shift.
Setup Time Reduction of machine using SMED technique & Lean manufacturing	N. S. Jagtap,V. D. Ugale, M. M. Kadam, S. S. Kamble, A. V. Salve **2015**	IJAPME	SMED	1) The tool is core competency to improve & implementing Lean manufacturing system & helps in batch manufacturing industry. 2) Here use ECRS principle [Eliminate, Combine, Reduce, Simplify]
Production Planning & process improvement in an impeller manufacturing using scheduling and OEE techniques	S.Vijyakumar, V.G.S Mani,N.Devraj **2014**	ELSEVIER	SMED	1) SMED tool provide details like availability, performance & bottleneck resource of critical component. 2) Two technique to solve improper scheduling & Higher set up time
Study and Implementation of Single Minute Exchange of Die (SMED) Methodology in a Setup Reduction Kaizen	Silvia Pellegrini, Devdas Shetty and Louis Manzione **2013**	International Conference on Industrial Engineering and Operations Management	FAST SMED	1) The scientific approach to solve the problem using Deming PDCA cycle & implement ideas for improvement using "Idea assessment prioritization Matrix " to evaluate the idea. 2) Here use FAST Technique [Foresight, Attachment, Setting, Trials runs & adjustment
Improvement of Plant Layout by using 5S technique-An industrial case study	Dinesh B. Shinde, Prashant N. Shende **2014**	IJMER	5S,Plant layout	1) Using 5S techniques improve the plant layout, improve visibility of problem condition, safety, reduce waste, improve OEE, and better impression on customer. 2) Material movement is reduce & then DPR is increase due to systematic arrangement.
Productivity Improvement by Enhancing the Bottleneck Station in an Alternator production Plant with Layout Improvement and its cost Analysis	Jubin James, Bobby john, Mahesh Rengaraj **2013**	International Journal of Scientific and Research Publications	CRAFT,TQM	1) Using CRAFT technique we could find an economic area of machine. 2) Bottleneck station is identified and improve Layout of station. 3) Green manufacturing, BPR, TQM, SCM Tools are used for improvement.
Analysis Plant Layout for Effective Production	R. D. Vaidya, P. N.Shende, N. Ansari, S. M.Sorte **2013**	IJEAT	FPC & CRAFT	1) Using FPC & CRAFT technique of each product studies & analysis. 2) Proper sequence between in machine shop for convenient material flow to improve productivity.
Improvement in Plant Layout Using Material Handling Technique	Amrita Kirtane, Nagendra Sohani **2014**	International Journal of Science and Research (IJSR)	Material handling technique	1) Travel chart technique is applied to minimize waste of time, Manpower, money, to generate profit for the same work. 2) Different process chart, REL, templet, scaledmodel, diagram are used to analysis data.
Overall Equipment Efficiency (Oee) Improvement Through Integrating QualityTool: Case Study	Perumal Puvanasvaran1, Chan Yun Kim , Teoh Yong Siang **2013**	International Conference on Design and Concurrent Engineering	FMEA ,Value stream mapping	1) Implementation of quality tools are on analyzing the problem found in the previous stage of study and proposed alternative remedies to optimize the OEE. 2) FMEA and Value stream mapping is also use.

Conclusion

There are number of factor affecting the productivity. Mainly the factor is improper workflow, unnecessary operations, poor workmanship, improper material handling. Out of all Lean tools TPM and SMED are most widely used in any industry and it reveals from literature review. 5's,Kaizen are part of TPM implementation. After successful implementation of TPM, it is found that Overall Equipment Effectiveness is increased. SMED reduce long set up time into single digit number. If organization wants to sustain in financial crisis then continuous improvement is the only key to survive.

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