Proceedings of Conference On Insights in mechanical Engineering (IME-19)
In Association with Novateur Publications IJIERT-ISSN No: 2394-3696
ISBN. No. 978-93-87901-04-9
March, 1st March 2019

Paper ID MD 05

LEAN TECHNIQUES USED IN DIFFERENT MANUFACTURING INDUSTRIES REVIEW PAPER

Prof. Prafull Arun Kamble
Faculty of Mechanical Engineering Department, Pandharpur India.
Prafullkamble.4444@gmail.com

ABSTRACT:
Lean manufacturing is a proper method for waste reduction within a manufacturing system without giving up productivity. Lean also considers waste created through overburden and waste created through varying in workloads. Working from the point of view of the client who consumes a product or service, "value" is any action or process that a customer would be willing to pay for. Lean manufacturing makes clear what adds value, by reducing everything else. This management philosophy is derived mostly from the Toyota Production System and identified as "lean" only in the 1990s.[1], for numerous, lean is the set of "tools" that helps in the recognition and steady elimination of waste. As waste is reduced quality improves while production time and cost are reduced. An incomplete list of such tools would include Kaizen, Just in time, Five S, Kanban, poka-yoke, total productive maintenance, SMED, value stream mapping. In this paper, an effort has been made to build up a lean tools survey for the associations to execute the lean manufacturing system. Examinations of the investigative literature survey are summarized in this paper to illustrate the execution sequence of lean tools and techniques.
Key Words: Lean, SMED, value stream mapping, Five S, Kanban, poka-yoke

INTRODUCTION:
Lean Manufacturing or Lean Production is a set of tools and methodologies that focus on the continuous reduction of all waste in the production process. The main advantages of this are lower production costs; increased output and shorter production lead times. Most of these advantages lead to lower unit production costs – for example, more effective use of equipment and space leads to lower depreciation costs per unit produced, more efficient use of labor results in lesser employment costs per unit produced and lesser defects lead to a lesser cost of goods sold. Many of the concepts in Lean Manufacturing originate from the Toyota Production System (TPS) and have been implemented gradually throughout Toyota's operations beginning in the 1950s. After the 1980's Toyota had become more known for the success with which it had implemented Just-In-Time (JIT) manufacturing systems[5].Today, Toyota is often considered one of the well-organized manufacturing companies in the world and the company that sets the standard for best practices in Lean Manufacturing. The concept "Lean Manufacturing" or "Lean Production" first found in the 1990 book The Machine that Changed the World [24]. Lean practices that are meant to improve the system may be relegated in favor of ensuring more goods are Processed [2]. Further Different lean tools and their surveys used to reduce the waste and increase the production rate are discussed in details.

KAIZEN:
Kaizen is a combination of two Japanese words "kai" and "zen" kai means to change or modify and zen means to improve or make better and together they translate as the improvement. kaizen when used in the context of management process, has come to mean as continual and slow improvement in every aspect of management (i.e. improvement in whatever company does and the way it does things) through the active involvement of all company's employees kaizen does not just merely means doing thing better but it is an unending process to eliminate Muda (i.e. waste) improve quality cost and delivery/ thereby creating more and more satisfied few definitions of kaizen are-
Kaizen is management supported employee-driven process, where employees seek development of their own capabilities by challenging the existing system and finding improvement in them. Kaizen process consists of seven in order steps built on well-known PDCA cycle for identifying and fixing problems. These seven steps are

1) Defining the problem
2) Understanding / assessing the current status

3) Finding the root cause
4) Planning countermeasures
5) Verifying results
6) Implementing countermeasures
7) Standardizing and establishing control.

The aim of kaizen is to remove waste through the incremental and continuous improvement of operations [5]. Kaizen employs a set of techniques namely five 5s for workplace improvement, Muda elimination, poka-yoke, SMED, TPM, JIT, kanban, pom, visual management, work standards, suggestion system etc. Mohd Ghazali Maarof Et al in their research found that the factors such as good communication between the top management and their employees, clear corporate strategy, the presence of a Kaizen champion personnel in the organization, good knowledge management, and employees empowerment were found to contribute to the successful implementation of Kaizen [7]. Mohd Ghazali Maarof Et al. have discussed the problems faced by the organization in implementing Kaizen include factors such as the lack of ability to manage the continuous improvement itself, the resistance to changes and lack of motivation among the employees due to poor reward system[7]. Mohd Ghazali Maarof Et al says that one method to improve business competitiveness is by applying the concept of continuous improvement also known as Kaizen [7]. Jennifer A.Farris et al concluded that Kaizen events are an increasingly common organizational improvement mechanism aimed at work area transformation and employee development [4]

POKA-YOKE:

Poka-yoke is a combination of two Japanese words" poka" meaning inadvertent errors and yoke (derived from Japanese word yokerie) meaning to avoid and together they translate as error/mistake proofing or fool proofing or falsifying a work process system to eliminate inadvertent errors. Poka-yoke is a powerful and comprehensive tool for identification measurement and analysis of mistakes/defects at the gemba (real place of work) and implementation of measures that prevent the activity from being a production of quality goods and services. Six popular poka-yoke devices are 1) Guide pins/locators, 2) error detection buzzers/ alarms and blinking lights, 3) limit switches 4) counter 5) color coding and 6) checklists.

Table 1. Few examples of falsifying (Production and operation management by Prof. L. C. Jhamba) [25].

Sr. No.	Problem mistake	Falsifying (Poka Yoke)
1	Address on the letter and envelope are different resulting in defective delivery	Letter put in window envelop
2	Transparencies wrongly exhibited on the screen (upside down)	Provide some mark (say arrow facing screen) on the transparencies
3	Spelling Mistake by the secretary	Use computer program that check to spell
4	Employee not Performing the work as per instructions	Instructions not clearly understood Ask employ to repeat instructions

usekeeping is the foundation for and the first steps towards quality achievement in a manufacturing organization. It boosts employee morale and inspires customer confidence. A sound mind in a sound body is the well-known age old saying. Similarly, good quality management practices can prosper only in the clean and serene atmosphere. 5-s (seiri, seiton, seiso,seiketsu and shtsuke) are considered in Japan the basics of any job. A 5-s principle has been practiced in Japan to establish and maintain the environment in the organization. Japanese management is of the view that if the housekeeping in a plant is weak, no further diagnosis is needed to know as to why that plant produces a poor quality product. A 5-S technique has been defined as a systematic and rational approach to workplace organization and methodical housekeeping with sense of purpose.5S are actually 5 Japanese words seiri, seiton, seiketsu, and shitsuke. Relationship between 5-S seiri (Organization) Seiton (maintenance) Sieso (Cleanup) Seiketsu (standardization)Shitsuke (Discipline).

Seire: Seire means sorting out unnecessary items in the workplace and disposing them off.

Seiton: Means arranging necessary items in prefixed locations:

Seiketsu: Means maintaining a high standard of housekeeping and work for organization at all times.
Seiso: means cleaning the workplace completely and regularly.
Shitsuke: - Means Training/ educating employee to follow housekeeping rules strictly.

The 5S (sort, set, shine, standardize and sustain) lean tool has been known to improve system performance [2]. 5S is a Japanese method of organizing the workspace, in a clean, efficient and safe manner, in order to achieve a productive work environment [3]. 5S method, which is used in organizations to remove, respectively elimination of waste in the workplace through five steps. The 5S method is necessary to include in the standardization of processes and lean workplace. The profit of standardized work contains documentation of the current process for all shifts, reductions in changeability, easier training of new operators, reductions in injuries and strain, and a baseline for improvement activities. Standardizing The work adds discipline to the culture, an element that is frequently neglected but essential for lean to take root. Identical work is also a wisdom tool that supports audits, promotes trouble solving, and involves team members in developing poka-yokes. The continuously improving component parts are, somehow, a way to improve the performance of the entire process [1]. 5S method to include in the standardization of processes and lean workplace [6].

KANBAN:
The working of the kanban system can be compared to supermarket shelf which is continuously monitored and refilled as customer help themselves. At the supermarket customer pickup quantities of goods they need at periodic interval employee checks up to see what customers have taken and he puts back what customer has taken and he puts back he has been taken. It is not mentioned anywhere that to instruct the employee what items and their quantities he should put on the shelves. Quantities picked by the customer are the quantities he should put on the shelves. Quantities picked by the customer are the quantities put on the shelves by the employee. The kanban system exactly does this. Kanban is simple but effective controls that help JIT production work kanban is the Japanese word for cards and the use of cards in central to many Japanese control systems including the one at the Toyota whose kanban system has received much attention. Kanban system signals may be one of the following. Like other systems, kanban was created to fulfill the specific needs of a company (Toyota), i.e. to work effectively under specific production and market conditions [10]. Using a Kanban system is a strategic operational decision to be used in the production lines [12]. card on which is written the part number, size of the container, number of pieces to be held by the container and number of these cards in the system. The basic idea is to use visual signals to coordinate the flow of work with process capacity, limit the waste of work interruption, minimize excess inventory or delay due to scarcity, prevent needless rework, and give a means of tracking work progress. In knowledge work, the components of production are ideas and information. In software and systems, the kanban concept has converted into a way of smoothing flow by balancing work with resource capability [8]. It aims more on restrictive work in progress according to capacity. Work cannot be started until there is an available proper source. In that way, it is characterized as a “pull” system, since the work is pulled into the process rather than “pushed” via a schedule. Richard Turnera et al. In their research, they have defined a visually monitored set of process steps adding value to work units that flow through them. Each step has its own queue and set of resources [8]. The
Fact that queues are included in the system allows costs of delay and other usually invisible aspects of scheduling to be integral inputs to decision making
[8]. The visual representation of the work is critical to kanban success because it provides an immediate understanding of the state of flow through the set of process activities. [8]
F.T.S Chan has tried to investigate the effect of varying the size of kanban on the performance of just in time (JIT) manufacturing system [9]. F.T.S Chan has found the result as the kanban size increases the fill rate decreases whilst with both in-process inventory and the manufacturing lead time increased. Also, they have observed that for multi-product manufacturer as the kanban size increases the fill rate increases with a decrease in the manufacturing lead time [9].

Ahmad Naufal et al, have concluded from their work carried out that implementation of kanban system would reduce lead time, minimize inventory on the floor and optimize storage area. [11]

JUST IN TIME (JIT):

Just in time is to produce and deliver finished goods just in time to be sold, make sub-assemblies just in time to be assembled into finished goods, fabricate/ purchase parts just in time to go into subassemblies and procure raw material just in time to be transformed into fabricated parts. JIT though cuts down drastically the inventory at different stages yet it is not just a way to reduce inventory rather it is means of solving problems that block the building of an excellent manufacturing organization. JIT, in fact, is a complete business philosophy and the process of thinking of working and managing to eliminate waste.

Toyota the originator of the JIT concept defines waste as anything other than a minimum amount of equipment material parts and working time absolutely essential to production. Edward hay, an authority on JIT defines waste as anything other than the absolute minimum resource of material, machines, and manpower required to add value to the product. JIT thus aims at reduction (if not elimination) of the non-value added activities (called waste full activities) such as moving work around, loading/unloading carrying, storing,

Stocking, counting, scheduling, impacting, reworking and thereby enabling the firm to concentrate on value-added operations like machining, heat treatment, assembly, and packing. JIT, therefore, is not just an inventory control or inventory reduction technique. It is philosophy or an approach to productivity which is applicable to all facets of the manufacturing process including Material. JIT approach, when applied systematically reduces or eliminates waste from purchasing, manufacturing, distribution and all other support activities of a manufacturing enterprise. Further, it is not restricted to Manufacturing activity alone but can be successfully applied to office systems as well Service organizations can also benefit from the elimination of non-value added activities thereby adding to their efficiency and profitability (or cost saving). The focus of operations management has been on continuously improving operations excellence through the development and implementation of strategies designed to improve organizational performance [23].

R. Anthony Inmana et al. in their research work have found that JIT-purchasing has a direct positive relationship with agile manufacturing while the positive relationship between JIT production and agile manufacturing is mediated by JIT-purchasing [21].

Kenneth W. Green Jr et al found the results of this study support T-JIT as available supply chain strategy that influences overall supply chain competency, contributing to organizational performance [22]

Kakuro Amasaka in his work have spoken about new JIT consists of the Total Development System (TDS), the Total Production System (TPS) and the Total Marketing System (TMS), which are the three core elements required for establishing new management technology principles for sales, R&D, design, engineering, and production, among others

[22]. New JIT is the basis of "Manufacturing Fundamentals 21C" accomplished by innovating the conventional JIT system [24].

SMED FOR SETUP TIME REDUCTION:

To maintain its market share in a competitive market, every organization must increase the line of its products accept low volume orders, shorten delivery lead time and decrease production batch sizes. It should also reduce inventory levels in the production and inventory systems. Since small batches will require frequent change over production capacity is expected to shrink unless setup times are reduced. Setup time reductions, therefore, is the key to developing or monitor a company's competitiveness in today's market where more diversified products are desired at short production lead times.

Setup time is a time required to prepare a machine or a group of machines to change over from job to another and SMED (an acronym meaning the single minute exchange of dies) is the tool helps to reduce setup time. SMED simply that die changes (equipment setup in general) should be completed in a single digit number of minutes. The activities performed by stopping the machine are called internal set-up time and the other hand the actions are performed without stopping the machine; these activities are called external set-up time [13].

SMED has four stages: i) preliminary stage, ii) Separating internal setup into external setups iii) Converting Internal Setup to external setup, and iv) Streamlining both internal and external setup. Tools helpful for setup time reduction are CFT Videotaping, Setup demonstrations, Production study, Visual display of setup time achievements and PERT/ CPM. Two examples related to preparation of tools/ dies/ moulds as offline activity are discussed below

Table 2.Example of setup time reduced by preparing tools. (Production and operation management by Prof. L. C. Jhamba)[25].

Sr. No.	Before	After
1	Dies at a die casting machine in a cold condition which were gradually heated to the appropriate with appropriate temperature by injecting the molten metal/plastic metal. Thi trial run out only form a part but also cause initial casting to be defective and needed to be remolded	A special rack was built and installed at the side of die casting machine. Dies to be used in following operation were pre heated by heat dissipating from the oven. This reduces the setup time to 30 minutes. Similar concept was used in plastic company wherein the moulds for plastic molding machine were preheated by warm water through coolant hose.
2	In a wire drawing machine the internal setup operation of changing the spool used to consume almost 20 minutes.	The changing of spool eliminated by connecting the end of wire being processed to the start of the wire of the next spool

M. Kemal Karasu et al, propose the Taguchi experimental design to the trial run phase of a changeover operation to get the parameters that give the first correct product. After some trials lead less time needed to start mass production and also less waste of material [14].

Mashitah Mohamed Esa et. al. has made attempt to identify the factors that influence high setup time and have taken the action that can be minimized to reduce the set-up time. Factors such as method, man and machine have been identified as factor lead to high setup time. They have also found that converting internal operations to external operations it helps workers in an assembly line to focus and concentrate more on activities in assembly line without less movement [15].

Pablo Guzman Ferradas et al have found that by Implementing the new tailored SMED improvement programme, the company achieved a 33% reduction on changeover time [16].

M. Brito et al in their work-study and experiment have found that the setup time of 105 minutes which caused productivity problem and delay for a customer was reused by 46% by implementing SMED tool and by increasing ergonomic condition of the workers [17].

TOTAL PRODUCTIVE MAINTENANCE:

We accept our machines to work without failure, produce high-Quality output, at the same time consumes very less manpower raw materials, electrical energy tools/ consumables etc. but it is highly complicated to understand in practice unless the approach is towards identifying the losses and eliminating them. TPM Total productive maintenance provides a way to achieve and maintain high levels of productivity. TPM is based on zero loss concepts Viz. Zero accident, zero defects, and zero breakdowns which render equipment highly effective TPM seeks engagement from intra and inter-department in an organization to maximize the overall effectiveness of production equipment. It involves production and maintenance staff working together as a team to reduce wastage, minimize downtime toward improving the end – product quality.

M.C. et al in their literature reports that the requirement for optimal preventive maintenance using, for instance, just in- time (JIT) and total Quality-management (TQM) techniques as given rise to what has been called the total productive maintenance (TPM) approach [20].

Ranteshwar Singh et. al. have concluded that Success of TPM depends on various pillars like 5-S, Jishu Hozen, Planned Maintenance, Quality maintenance, Kaizen, Office TPM and Safety, Health & Environment [19].

Adnan Hj. Bakria et al. say that TPM brings maintenance into focus as a necessary and vitally important part of the business. TPM seeks engagement from intra and inter-department in an organization to maximize the overall effectiveness of production equipment [18].

CONCLUSION:

The conclusion of this survey reveals that the successful Lean Manufacturing System execution needs collection and simultaneous administration of Lean elements along with suitable order. The surveys also

choose the detailed implementation preparation which gives a combined theory for Lean Manufacturing System implementation. Thus the proposed implementation tools reduce the implementation time and reduce manufacturing system bifurcation. As a result, it is recommended that the Lean Manufacturing System can undergo in a competitive business environment. Future research should try to find arrange structures in-line with pull system by considering the complete lean elements.

REFERENCE:

1) Mariano Jiménez, Luis Romero, Manuel Domínguez , María del Mar Espinosa, "5S methodology implementation in the laboratories of an industrial engineering university school", Safety Science 78 (2015) pp.163–172.
2) Oleghe Omogbaia, Konstantinos Salonitisa, "The implementation of 5S lean tool using system dynamics approach, Procedia CIRP 60 (2017) pp. 380 – 385.
3) Cristina Veres (Harea) Pa, P0F, Liviu MarianPaP, Sorina MoicaPbP, Karam Al-Akel, "Case study concerning 5S method impact in an automotive company", Procedia Manufacturing 22 (2017) pp. 900–905.
4) Jennifer A.Farris , Eileen M.VanAken, ToniL.Doolen, June Worley, "Critical success factors for human resource outcomes in Kaizen events: An empirical study", Int. J. Production Economics 117 (2009) pp. 42–65.
5) Jose Arturo Garza-Reyes, Vikas Kumar, Sariya Chaikittisilp, Kim Hua Tan, "The effect of lean methods and tools on the environmental performance of manufacturing organizations", International Journal of Production Economics 200 (2018) pp. 170–180.
6) Miroslava MÍkvaa,, Vanessa Prajováa, Boris Yakimovichb, Alexander Korshunovb, Ivan Tyurinc, "Standardization - one of the tools of continuous improvement", International Conference on Manufacturing Engineering and Materials, ICMEM 2016, 6-10 June 2016, Nový Smokovec, Slovakia, Procedia Engineering 149 (2016) pp. 329 – 332.
7) Mohd Ghazali Maarof, Fatimah Mahmud, "A Review of Contributing Factors and Challenges in Implementing Kaizen in Small and Medium Enterprises", 7th International Economics & Business Management Conference, Procedia Economics and Finance 35 (2016)
8) pp. 522 – 531.
9) Richard Turnera, Dan Ingoldb, Jo Ann Laneb, Ray Madachyc, David Anderson, "Effectiveness of kanban approaches in systems engineering within rapid response environments", New Challenges in Systems Engineering and Architecting Conference on Systems Engineering Research (CSER) 2012 – St. Louis, MOProcedia Computer Science 8 (2012) pp. 309 – 314.
10) F.T.S. Chan, Effect of kanban Size on just in time manufacturing System, Journal of material processing technology, 116 (2001) pp (146-160).
11) Muris LageJunior, MoacirGodinhoFilho, "Variations of the kanban system: Literature review and classification", Int. J. Production Economics 125 (2010) pp.13–21.
12) Ahmad Naufal*, Ahmed Jaffar, Noriah Yusoff, Nurul Hayati, "Development of Kanban A system at Local Manufacturing Company in Malaysia Case Study", International Symposium on Robotics and Intelligent Sensors 2012 (IRIS 2012), Procedia Engineering 41 (2012) pp. 1721 – 1726.
13) Nor Azian Abdul Rahmana, Sariwati Mohd Sharif b, Mashitah Mohamed Esa, "Lean Manufacturing Case Study with Kanban System Implementation, International Conference on Economics and Business Research 2013 (ICEBR 2013), Procedia Economics and Finance 7 (2013) pp 174 – 180.
14) R.Sundara, A.N.Balajib, R.M.Satheesh Kumar, A Review on Lean Manufacturing Implementation Techniques, 12th global congress on manufacturing and management, gcmm 2014, Procedia Engineering 97 (2014) pp. 1875 – 1885.
15) M. Kemal Karasu Mehmet Cakmakci. Merve B. Cakiroglu , Elif Ayva , Neslihan Demirel-Ortabas, "Improvement of changeover times via Taguchi empowered SMED/case study on injection molding production", Measurement 47 (2014) pp. 741–748.
16) Mashitah Mohamed Esa, Nor azain Abdul Rahman, Maizurah Jamaludin, "Reducing High
17) Setup Time in an assembly line: A Case Study of Automotive Manufacturing Company in Malaysia" 2nd global conference on business and social science 2015.GCBSS-2015, Bali, Indonesia, Procedia - Social and Behavioral Sciences 211 (2015) pp. 215 – 220.

18) Pablo Guzmán Ferradás, Konstantinos Salonitis, "Improving changeover time: a tailored SMED approach for welding Cells", Forty-Sixth CIRP Conference on Manufacturing Systems
19) 2013, Procedia CIRP 7 (2013) pp. 598 – 603.
20) M. Brito, A.L. Ramos, P. Carneiro, M.A. Goncalves, "Combining SMED Methodology and ergonomics for reduction of setup in turning production area"Manufacturing Engineering
21) Society International Conference 2017, MESIC 2017, 28-30 June 2017, Vigo (Pontevedra), Spain. Procedia Manufacturing 13 (2017) pp. 1112–1119.
22) Adnan Hj. Bakria*, Abdul Rahman Abdul Rahimb, Noordin Mohd. Yusofc, Ramli Ahmad, "Boosting Lean Production via TPM", International Congress on Interdisciplinary Business and Social Science 2012, Procedia - Social and Behavioral Sciences 65 (2012) PP. 485 – 491.
23) Ranteshwar Singh, b Ashish M Gohil, b Dhaval B Shah*, c Sanjay Desai, "Total Productive Maintenance (TPM) Implementation in a Machine Shop: A Case Study", Chemical, Civil and Mechanical Engineering Tracks of 3rd Nirma University International Conference on Engineering (NUiCONE 2012), Procedia Engineering 51 (2013) pp. 592 – 599.
24) M.C. etal, S.O.T. ogaji,and S.D. Probert, implementing total productive maintenance in Nigerian manufacturing industries. Applied Energy Volume 79 Issue 4, December 2004, pp. 385-401.
25) R. Anthony Inmana,∗, R. Samuel Saleb, Kenneth W. Green Jr. c,1, Dwayne Whittend," Agile manufacturing: Relation to JIT, operational performance and firm performance". Journal of Operations Management 29 (2011) 343–355
26) Kenneth W.GreenJr, R.AnthonyInman, LauraM.Birou, DwayneWhitten, "Total JIT (T-JIT) and its impact on supply chain competency and organizational performance". Int. J.Production Economics147 (2014)125–135.
27) Kakuro Amasaka, "New JIT, New Management Technology Principle: Surpassing JIT", CENTERIS 2014 - Conference on ENTERprise Information Systems / ProjMAN 2014 - International Conference on Project MANagement / HCIST 2014 - International Conference on Health and Social Care Information Systems and Technologies. Procedia Technology 16 (2014) 1135 – 1145.
28) Womack, James P; Daniel T. Jones; Daniel Roos (1990). The Machine That Changed the World.
29) Text book: Production and operation management by Prof. L.C. Jhamba.