IMPLEMENTATION OF VARIOUS LEAN TOOLS IN DIFFERENT MANUFACTURING INDUSTRIES: A LITERATURE REVIEW

Rohit Phatak[1], Asheesh Deshpande[2], Aniket Bhandare[3]

ABSTRACT
Lean Manufacturing is an organized method designed to minimize waste in a manufacturing system and increase productivity. Lean Tools are a set of tools which aim to improve production efficiency by getting the most out of each available resource. In the present era of globalization, different manufacturing industries are adopting new techniques to compete with each other and survive in the market. Applying Lean philosophies is one of the most important aspects that help businesses thrive in today's competitive world. The different research papers on Lean Tools are studied and their applications in specific industries as well as the outcomes and necessary parameters for applying these tools are analyzed. Around 25 research papers were studied across a wide range of industries. It is also noted that which of these tools have the most significant impact on the general efficiency and productivity of the organizations.
KEYWORDS: *Lean Tools, Manufacturing, Efficiency, Cycle time, Waste, Lead time*

INTRODUCTION

Manufacturing companies all around the world are always looking for ways to make the different processes involved in the manufacturing of a product more efficient. To achieve this, many companies make use of Lean Tools like Kaizen, Kanban, 5S, TPM, etc. The main objective behind using Lean Tools is to reduce errors that occur in the manufacturing process and make the overall processes more efficient. This in turn results in reducing wastage and makes the processes more economical.

In this paper, an effort is made to present a review of the available literature and to recognize the critical concepts which are essential to the implementation of Lean.

OBJECTIVES
- To understand the extent of implementation within different manufacturing sectors.
- To analyze the advantages and limitations of Lean Tools in production.
- To evaluate the specific application of Lean Tools.
- To study which Lean Tools are the most significant and which ones have the least relevance.

LITERATURE REVIEW

Mr. Ioannis Belekoukias, Dr. Jose Arturo Garza-Reyes, Dr. Vikas Kumar [1] conducted a study that focuses on the five tools which are JIT, Autonomation, Kaizen, TPM and VSM. They conducted a questionnaire survey in 710 organizations which aimed to find out which of these Lean Tools were implemented and the extent of their implementation. Then the survey data was analysed using correlations, structural equation modelling (SEM) and regressions. The result of this study was that out of the five tools, JIT has the highest impact on the overall improvement in the performance of an organization.

Mandar Mukundrav Sumant, Pritesh Ratilal Patel [2] study identified the application of 13 different Lean Tools (JIT, 5S, VSM, Kanban, Kaizen, SMED,

Poka-yoke, Six Sigma, TPM, Jidoka, Standardized Work, Visual Factory, Andon). It was found out that out of these 13 tools, 5S, JIT, VSM and Kanban had the most significant impact in improving the industrial sectors. 5S was the Lean Tool which was most preferred by the majority of the industrial sectors for waste elimination. Textile, Manufacturing, Process, Automobile and MSME were the sectors that implemented the majority of Lean Tools.

Ritesh R Bhat, Dr. Raviraj R. Shetty [3] study implied the different elements which are essential to the implementation of Lean Principles such as Manufacturing Flow, Process Control, Metrics, Organization and Logistics. They also clarified some misconceptions related to Lean Manufacturing which helps in understanding the broadness of Lean Tools. They also studied some researches which were conducted earlier and found out that VSM is the most suitable Lean Tool which can be implemented in complex working environment and proves to be the most efficient to identify the root cause of a problem.

R. Sundar, A.N. Balaji, R.M. Satheesh Kumar [4] conducted a study to identify the major Lean Tools and the parameters which are necessary for the implementation of these tools. They created a basic roadmap that creates a general guideline for the applications of these Lean Tools and the factors which are necessary for their execution. The roadmap specifies some other important aspects that are crucial such as buffer stacking in case of nonequivalence, design the Pull System with one-piece flow. They also specified the particular area of manufacturing in which they can be applied. The end goal of this roadmap is standardized and continuous improvement.

Alok Kumar Chaudhary, Pramod Bahadur Shrestha, Subodh Kumar Ghimire [5] carried out a study that aimed in the implementation of Lean Six Sigma in the precision tools and die sector. They applied VSM to map out the production flow layout in a tool production unit. They found out a couple of issues such as hardening and quenching defects. In response, they implemented an experimental approach for the standardization and optimization of hardening process. They further developed a new process parameter wherein the product hardness is within the specified limit and the product standard is assured.

Girish Deshmukh, Dr. Chandrakant Ramesh Patil, Mona Deshmukh [6] analysed how the Lean Tools affect the performance of the manufacturing industry. Firstly, they evaluated the value stream and then they analysed the production flow model to find out the areas in which Lean Tools can be applied to improve the overall efficiency. They further visited a few industries and studied the impact on them before and after the implementation of Lean. They finally concluded that Lean Tools definitely contribute to growth of profits and thus help in the increase of revenue.

V. Velmurugan, S. Karthik, S. Thanikaikarasan [7] conducted a time study to measure the work required in each manufacturing process. They did this by breaking down the manufacturing activities at workstation. Further they identified which of these manufacturing activities are redundant so that they can be eliminated to reduce waste and to make the processes more consistent. Thus it was found that by carrying out time study, the time taken for each work sequence can be reduced and this influences the overall cost.

Md. Saleem, Dr. Devendra Verma [8] studied the application of Lean Tools in Precision Surface Equipment industry. Initially, they created a 5S assessment sheet to understand the implementation of 5S in the workplace. Then they created different teams which were given different projects which all aimed at Lean Manufacturing. Furthermore, they created a monthly 5S audit scoresheet which showed an overall improvement in the 5S score. They prepared a QA matrix to solve the three major problems – Neck oversize, Neck undersize and Heavy toolmarks. To solve these problems, they used QC tools like fishbone diagram, IOM analysis, Pareto chart, YY analysis. Finally, they recommended some suggestions to apply Lean Tools in the PSE industry.

Adefemi O. Adeodu, Mukondeleli G. Kanakana-Katumba, Rendani Maldzh [9] studied a manufacturing industry with the aim of enhancing the output in the form of lead time, labour overflow. Initially they implemented VSM to understand the value chain of the production line. They implemented kaizen and 5S to improve the overall productivity by reducing the lead time and the takt time. They also minimized the manufacturing waste by work standardization and six sigma tools like 5S and DMAIC. Tools like line balancing and inventory management monitor were also used to control the overall inventory of the organization and to avoid excessive inventory storage.

Rajan Kumar, Ravi Kumar Dwivedi, Sudhir K Dubey, Anoop Pratap Singh [10] studied the automobile manufacturing industry and employed Poka-yoke technique to solve problems regarding the product quality and cost. Initially they created a PDCA cycle to efficiently implement Poka-yoke. They studied a 70x90x10 oil field which is used in the axle tube of a tractor. They encountered the problems of oil field leakage and the parts getting damaged due to excessive

pressure which occurs in the press machine. They converted the oil seal press machine into a PLC system and they created a system so that the tool selection is based on the component selection. The results of using Poka-yoke was that there was an overall reduction in defective products by 16.21%

J. Oliveira, J.C. Sa, A. Fernandes [11] conducted a study in which they analyzed the company that manufactures mechanical equipment. The production sector within the company is divided into four main areas and the aim was to determine which of these wastes are the most common ones. They found out that the most common forms of wastes were high stocks, distance between jobs, sudden equipment shutdown. Then, they looked at the different Lean Tools and the specific areas in which they can be applied. They concluded that TPM is the tool which can be used at every single level in the organization and implementation of TPM results in savings due to stable processes and a flexible production.

M. Kishore Kumar, A. John Rajan, R. Kaja Bantha Navas, S. Sahaya Rubinson [12] conducted a study in which they studied the application of Lean Manufacturing in a mass manufacturing industry which produces hydraulic cylinders. They created a method study to examine more effective ways in manufacturing a product and reducing the costs incurred. They also made changes in the arrangements of the process sheet and made it more systematic. They also changed the layout of the shop floor for better material movement. As a result of this, the company became more profitable due to increased manufacturing flexibility, quicker queue times and efficient utilization of labour.

Mpho Karen Masemola, Bheki Makhanya, Hannelie Nel [13] conducted a study in a South African manufacturing company where they created a questionnaire for about 60 management employees to understand the level of experience of people in Lean Manufacturing, their job titles and also the types of waste generated. Then they analyzed this data using graphs and concluded that the company was currently using 3 Lean Tools and was mainly affected by 4 types of wastes. They suggested that the company should implement VSM, SMED and TPM to reduce wasting time and to increase the efficiency of the organization.

Geeta M. Amin, Dr. Mohit B. Diwan [14] carried out a study for the implementation of Lean Tools in pipe manufacturing industry. They observed all the activities on the production shop floor and each operation process which is involved in the manufacturing of the final product. They applied 5S to reduce the overall cycle time which results in saving of costs. They also executed VSM to understand the entire process of manufacturing a pipe and also compared different types of pipes. They concluded that VSM is the most powerful tool which improved the performance of process without any expenditure.

Vasudev Krishnan, C. Mallika Parveen [15] studied around 180 different manufacturing firms in different sectors ranging from Petroleum, Telecommunication, Machine Tools, Electronics, Automotive etc. They observed that in the majority of the manufacturing industries TPM was the major Lean Tool employed. TQM also shows considerable amount of application in manufacturing firms although not as high as TPM. Six sigma is the lean tool with least application within the manufacturing industry. Within the healthcare sector, they observed that a lot of managerial philosophies within the hospital correspond to tools used within lean manufacturing. They found out that Kaizen which stands for continuous improvement was the most employed lean tool in healthcare. TQM is the second highest adopted tool and the application of Six Sigma is negligible within the healthcare industry. They concluded by creating an integrated list of lean tools used in both manufacturing and service sectors and found out that TQM, JIT and Human Resource tools were the most common tools with Human Resource Tools having a lot of relevance in the service sector.

J Kaneku-Orbegozo, J Martinez-Palomino, F Sotelo-Raffo, E Ramos-Palomino [16] studied the application of Lean Manufacturing Tools in a kitchen equipment manufacturing company. Initially they recorded the lead time of raw material and the time required to deliver the finished products to the customers. They mapped the whole production process in a VSM diagram and showed the cycle time and other metrics which are related to VSM. They employed standard operating procedures within the sectors of design, bending and cutting so that the cycle time would be reduced. They also prepared a proper maintenance plan for the machines used in production. The result of using these tools was a net 13% reduction in manufacturing costs.

Shubham Ghushe, Shubham Deshmukh, Vrushabhsingh Basgoti, Yogesh Yawale, Pratik Gangasagar, Prof. N.S. Duryodhan [17] studied the application of Lean principles in a Coir product manufacturing company which specializes in the production of mattresses. Initially they studied the various processes which are required in the manufacturing of coir products and then they employed Kaizen to reduce the lead time and also increasing the safety of the workers. They applied Poka-yoke to reduce the process time and also the mistakes which

occurred during the manufacturing process. VSM was used reduce the inventory time and increase total lead time. The results of using all these tools is reduction in waste and overall increase in the final quality of the finished product.

Muthukumaran V, Hariram VR, Padmanabhan KK [18] studied the Lean implementation in different manufacturing verticals like Automotive, Machine Tool, Construction, Electronics and Consumer products, Process and Textile. They observed that tools like Six Sigma, VSM, Kanban, Kaizen, Standardized Work, 5S were common across all the industries. They concluded by identifying that the implementation of Lean was highest in Automotive and Electronics industry owing to their huge requirement demand.

Virender Chahal, Dr. M. S. Narwal [19] prepared a correlation model of Lean waste and Lean Manufacturing strategies that help to eradicate industrial waste. They studied the Lean Tools and their respective requirements and further analyzed the various types of wastes such as overproduction, transportation, unnecessary motion etc. Furthermore, they created a Lean model which suggested the specific Lean Tools that are highly impactful for a given problem. They concluded by determining the best Lean strategy which can be used to overcome the particular waste.

Dr. N. Venkateswaran [20] encountered a major problem in a dump truck workstation. It was found that compared to other manufacturing units, the working hour was quite high, which in turn led to high production lead time. Lean methodologies such as Kaizen, Muda, Takt time were employed for waste elimination and minimizing lead time. A time study was conducted to recognize the more time consuming sub processes in each of the main assembly processes. After the implementation of Lean techniques, a reduction in lead time and improved production capacity was observed.

Fernando Romana [21] studied the implementation of Lean Principles in Small and Medium sized manufacturing companies based in Portugal. They studied a company which produces machine elements required for forging. They created an assessment plan flow chart and analyzed workstation procedures, lead time determination, OEE determination etc. They identified that the main category of issues was the high amount of wait time while performing the equipment setup and low equipment performance. They implemented solutions like Single Minute Exchange Die Tool and 5S, Lean philosophy to improve the setup time and overall equipment effectiveness results.

Karikalan R, Sreeharan B N, Akilan S, Rallish Rahuman Khan J [22] studied the Application of Lean tools in Automotive Welding Fixture Manufacturing industry to improve the overall productivity. They analyzed the machine parts and which of these parts got rejected. They applied 4W analysis, 1H analysis and Pareto chart to analyze why exactly did these parts get rejected. They found out that there was wastage of time due to failure in de-burring operations and the mixing of raw materials. They suggested that for solving the problem of identification of raw materials in DXF format BIN system should be implemented and Kanban should be applied to solve the problem of failure in performing deburring operations.

Bhuvaneshwari alias Sunita Kulkarni M, Anand H. Mishrikoti [23] studied the implementation of Lean tools in SMEs to improve production performance. They analyzed the specific Lean methodologies applied and their target area as well as the outcome of applying these lean tools. They also summarized the most commonly used Lean methodologies in SMEs as well as the most frequently faced challenges in the implementation of Lean. They found out that Lean tools were majorly used in Automobile industry followed by other manufacturing industries. They concluded that SMEs need to implement soft Lean aspects like 5S, last planner and teamwork which do not require significant monetary investments.

Nor Azian Abdul Rahman, Sariwati Mohd Sharif, Mashitah Mohamed [24] conducted a Lean Manufacturing case study with a focus on Kanban system. They carried out this research in an automotive manufacturing company. They implemented a Kanban system for sorting the inventory in the production line. They used an E-SIMS database to keep a track of the raw materials which are already used in the production process. The result of implementing this Kanban system was lower wastes, scraps and minimal operating costs.

W. A. Santosa and M. Sugarindra [25] studied the implementation of Lean Manufacturing in a musical instrument production company. The study focused on understanding the real condition of production lines and to identify the waste. The improvements were carried out with an objective to reduce cycle time and lead time. They identified the different types of wastes and categorized them and also proposed Kaizen to eliminate them. After applying Kaizen, a future state VSM was created. The result of implementing Kaizen was a reduction in cycle time and thus an overall improvement in the production efficiency.

EPRA International Journal of Research and Development (IJRD)
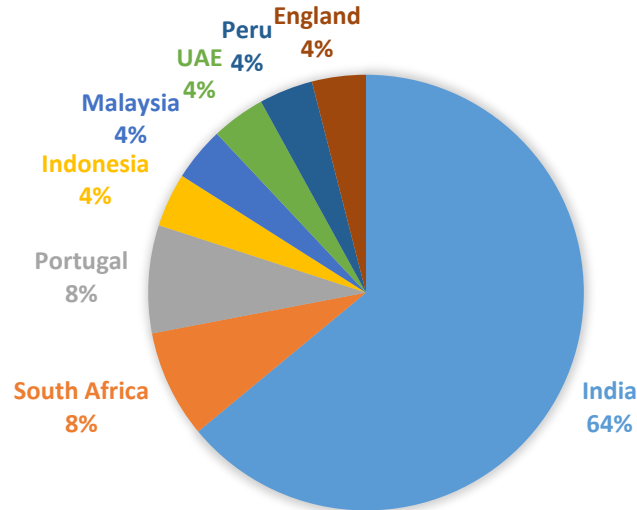
METHODOLOGY

We conducted a study of the literature using a theoretical approach in three different stages –

1. Review Planning
2. Selecting Academic Research
3. Discussion of Contributions and Conclusion

In the beginning of this study, we did a thorough research on Google Scholar on the different available research papers which were published in accredited journals. Keywords 'Lean Tools', 'Lean Manufacturing', were mainly used. We focused on research papers which were based on the manufacturing sector. We conducted a search in carefully selected journals in categories like industrial engineering and Lean management as these fields are the most relevant for our study. We selected 25 papers for our study, most of which aimed at improving the production efficiency.

The following criteria were used for paper selection:

- Papers published from 2013 to 2021.
- Papers written in English.
- Research conducted in manufacturing companies around the world.
- Papers published in authorized peer-reviewed journals.

Classification of Papers according to Publication Year
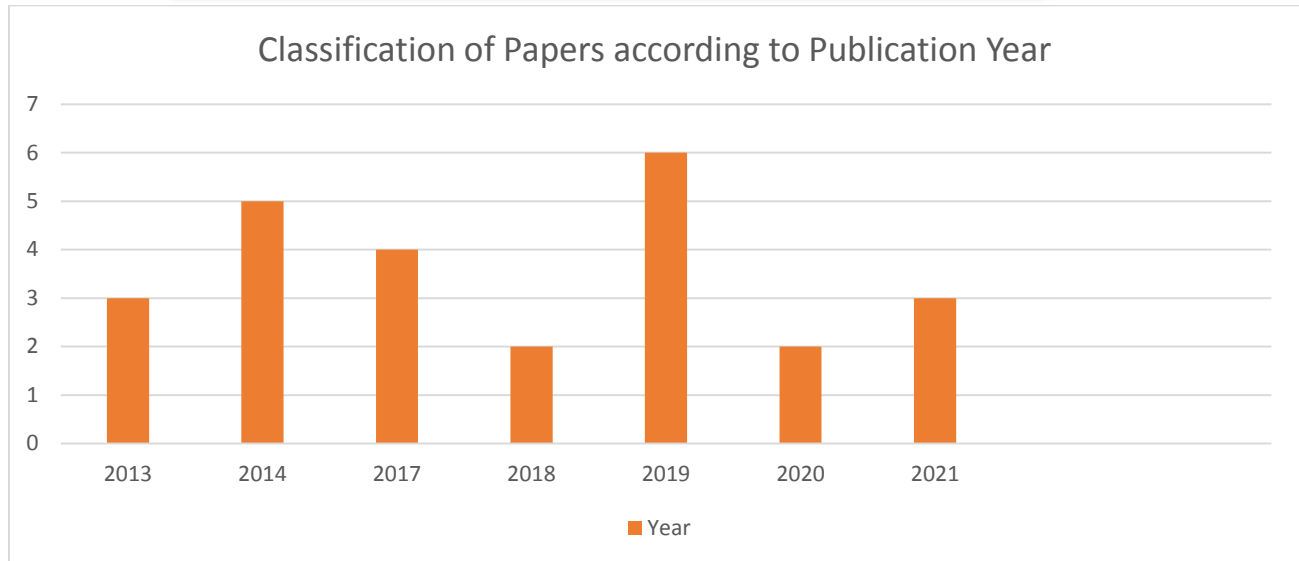

CONCLUSION

The research papers were thoroughly studied and we arrived at the conclusion that Lean Tools are an essential part of the manufacturing sector. It can be used at any level of the organization. There are a couple of Lean Tools that can be extensively used like VSM and TPM. Lean Tools basically help in waste reduction without sacrificing productivity in the manufacturing industry. Knowing its enormous benefits, maximum industries are trying to employ Lean Manufacturing.

Lean Tools mentioned in the papers
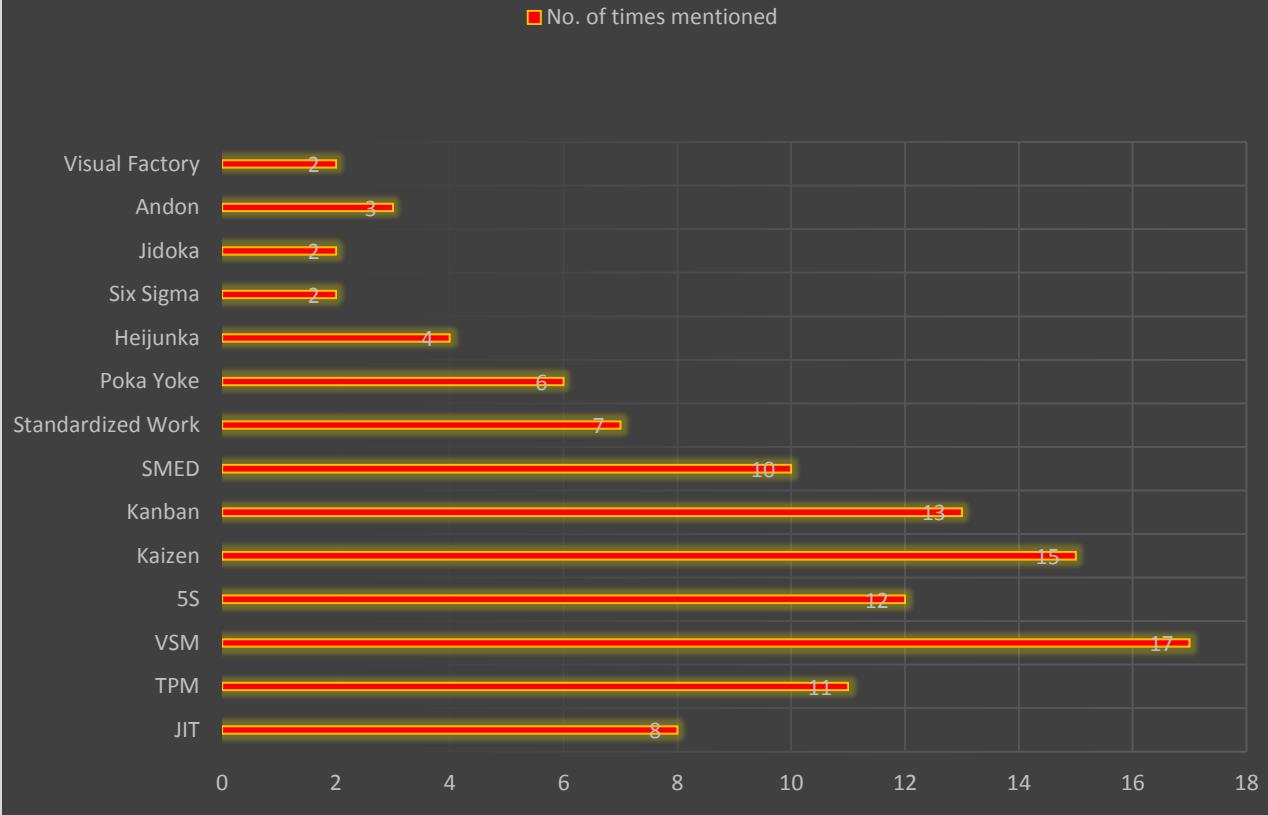
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