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Lean Manufacturing Practices – A Literature Review

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Abstract - *Survival of any industry in this era of globalization & a cut-throat competition becomes extremely difficult. In order to survive, it is necessary to adapt to this ever changing environment. Globalization has made this competition fierce & has also helped in developing techniques & methods that are exceedingly helpful for any industry to flourish even in today's times. Lean is one such tool that can be applied anywhere & everywhere in industry. From shop-floor to the top management, lean has proved its mettle. Application of lean reduces the wastes that are produced & also helps in streamlining the production system. It focuses on continuous improvement & at the same time reducing the wastage. Widely used techniques like Kaizen, 5S, Six Sigma, Value Stream Mapping (VSM) are a part of lean. Implementation of lean leads to all around development of any industry. This paper discusses comprehensive literature on implementation of lean manufacturing. The case studies considered in this paper includes work of international researchers.*

Keywords: *Lean Manufacturing, Continuous Improvement, Kaizen, Value Stream Mapping, 5S*

I. INTRODUCTION

To ensure the survival in this ever changing & developing market, implementation of lean practices becomes necessary. Before we move forward, we need to understand what is "Lean"? Lean, according to standard Oxford dictionary, is an adjective that means thin, especially healthily so; having no superfluous fat. Now, what is the "fat" in terms of industry? The so called "fat" is waste. Taiichi Ohno, while developing Toyota Production System (TPS), defined types of MUDA that should be avoided. Muda is the Japanese term for waste. It was Womack who first termed the coin "Lean" & introduced it to world in his book. This was after the fact that Toyota had become a world renowned company in a very short time.

Lean is a systematic approach, which focuses on increasing the productivity by eliminating waste. Now the waste can be of many types. Ohno specified seven forms of waste at first. By systematically preventing these wastes, growth of an industry can be achieved steadily & surely. Lean serves as a multi-purpose tool as it can be used to test the system efficiency & effectiveness. These wastes are shown in the diagram below.

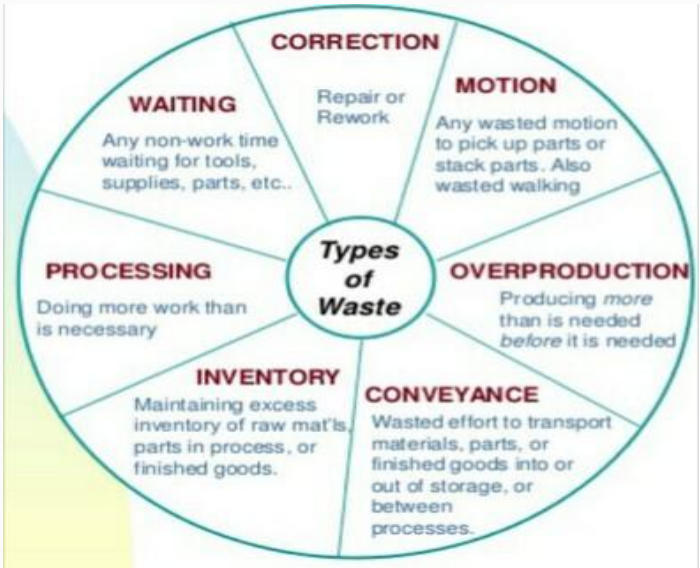

Figure. 1 Seven types of wastes occurring in an industry

Lean focuses on reducing these wastages, thus making the industry free from "fat". For this purpose, lean has many tools like Poka-Yoke, Takt Time, Andon, Kanban, etc.

II. METHODOLOGY

Implementing lean philosophy is necessarily a 5 step process which is to be performed sequentially. These steps are shown in the figure below.

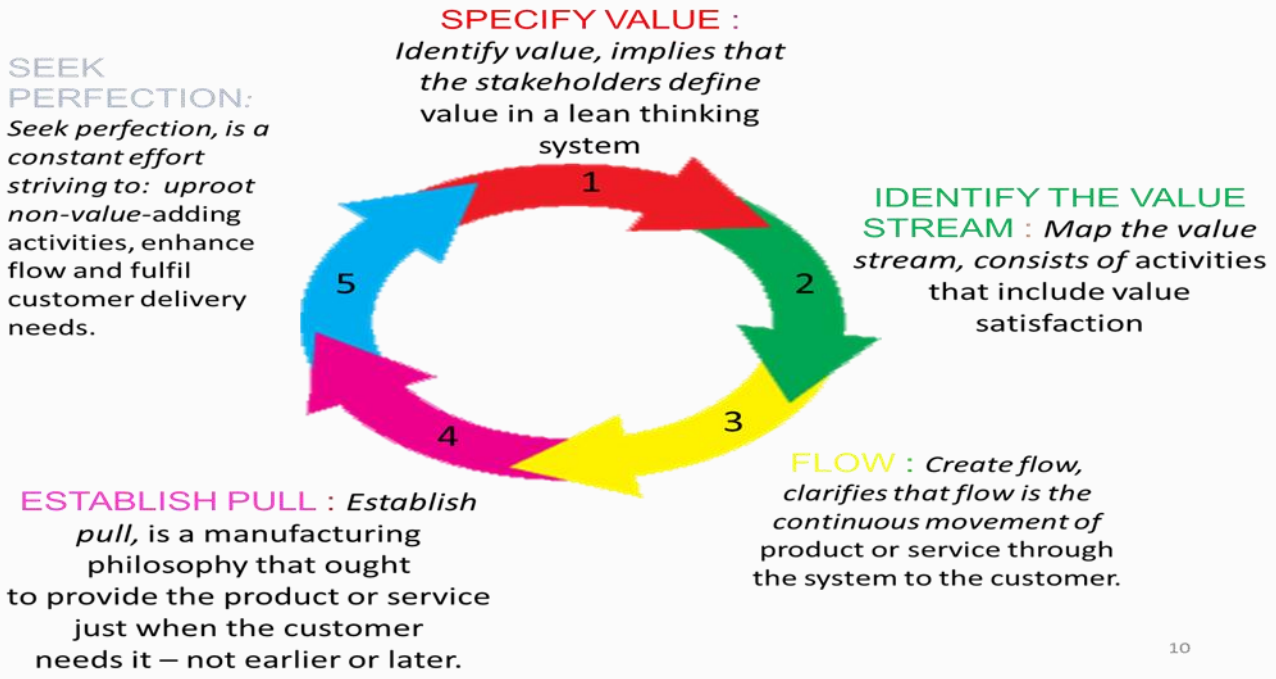

Figure. 2 Steps of Lean

III. LITERATURE REVIEW

Toyota Production System (TPS) revolutionized the manufacturing & production industries [28]. This system developed by Teichi Ohno serves as a benchmark for various multinational companies (MNC) [28]. Lean production is a system to have mass production in low cost [5]. Lean manufacturing basically means continuous improvement over production cost reduction and maintaining the quality as per the demand and remaining in the completion of market with time [4].

Value Stream Mapping (VSM) is one of the most powerful tools that lean offers [22]. A thorough study of system is done with help of VSM and appropriate corrective actions are decided [22]. Value stream mapping means to observe every process and to term whether it is a valuable process or not a valuable process and categorize it as per the requirement and try to increase the value of valuable process for the benefits of the company [9] VSM is not just limited to recognizing waste but it also helps in selecting appropriate lean tool that can be used effectively to eliminate this waste [22]. Now, as a conclusion very little rework is required to be done when value stream mapping is done so its benefits are good compared to its negligible disadvantages and depends on company how persistently they uses this method [10]. VSM can be used as a research tool. Also, VSM turns out to be the tool that can be used regardless of circumstance i.e. one can use VSM just to study the system, even when there is no corrective action required in order to keep a constant eye on the system performance.

Kaizen, in general, means improvement. Kaizen focuses on continuous improvement of system through various changes [2]. These changes, no matter how small, increase the performance of system. Now, kaizen costing method is a method for ensuring that a product meets or exceeds customer requirements for quality, functionality, and prices to sustain product competitiveness [2]. Kaizen costing basically means to have complete production at lower rate than the previous record so a target is set then work is done [2]. Kaizen focuses on doing relevant things that keeps a industry in top-gear for this cut-throat competition.

Kanban is a supply-chain inventory control tool [17]. It is a visual inventory management system where every material/semi-finished product has card on it, which contains necessary information related to it i.e. its ID number, storage rack number, etc. Kanban is widely used in industries where mass production is practiced [31]. The concept behind a Kanban system is to reduce costs in high volume production lines [17]. And also, to reduce production lead-times, which in turn reduces the amount of inventory required [17]. This tool helps in improving system throughput with high level of quality [17].

We know the term lean manufacturing it is related to mass production and cost reduction is its first priority and is less concerned with individual opinion and choices [8]. The agile manufacturing is a different term which prioritizes customer choice than its cost [8]. Now the problem is method that has to be followed by the sector & method which should not be followed [8]. The reputation of a bicycle company was at stake, so they tried modifying the cycle with new preferences which got their attention which resulted in only 15% more charge than the normal ones [8]. During winter times they continued the lean manufacturing which was demanded by the people [8] This paper shows the use of paradigm has to be combined with a total supply chain strategy particularly considering market knowledge and positioning of the decoupling point as is best suited to satisfying a fluctuating demand and lean manufacturing requires a level schedule [12]. Now the problem is that the workers need to be upgraded as per the preferences and then there will be proper production for company so the conclusion of this paper is not to depend on only one type of manufacturing but to change the system as per requirements [8]. The conclusion was to compare the lean and agile manufacturing paradigms, highlighting the similarities and differences [12]. Neither paradigm is better nor worse than the other, in fact are complementary within the correct supply chain strategy [12]. Problem faced while implementing it were the workers who are not ready to get used to new technique fearing losing their jobs. Lack of awareness and training, improper understanding of lean concept are the root cause of such problems & rigid mentality. Despite of these problems, Indian industries are trying to get used to lean technique and as per survey it is not fully implemented in any industry [1]. The cost is high to get training for lean manufacturing& so, other industries are not trying to get into this technique [1]. So, appropriate lean education and research set up in association with industries has to be fostered and encouraged to stimulate the lean awareness and higher technological standards in manufacturing [1].

Binding lean as a tool to be used only for engineering purpose is a great mistake & misconception. Lean has to cross its boundaries and can enter the medical field as one of the tool to cut the cost for manufacturing vascular stents for interventional radiology [4]. The challenge is that people will not consider any cost reduction in matters of medical field as they have their reasons to behave like that; but resources must be allotted properly and economically [4]. One of the reason is patient won't allow any reduction in its treatment cost, as they consider it might be a bad decision from their health point of view, and secondly it is the insurance company that pays for the treatment, so patients generally don't care what might be the treatment cost [4]. But the resources are getting reduced with time so a proper step should be taken within time to reduce inflation rate in treatment cause all won't be able afford it with time [4]. There are difficulties when there is long distance between customer and the supplier as the demand for product as per the requirements could not be met properly so the purpose of internet is to supply its inventory requirement as per the production if there might be product in inventory [5]. We won't be able to give one customer but there are lots of customer available in internet to them it could be supplied as per this research paper they have done analysis in industries there are companies they use lean via internet they were Dell, Cisco system, Odam, by using lean and internet together [5]. They got close to customers as their complaints were met easily [5]. Access to higher authority was done more reliably [5]. If there was any problem during production the easy group connectivity with technical team from different places is possible [5]. But there were some problems like highly protected data could not be shared as there was risk of cyber security; but raising the protection level and firewall system this problem could be avoided and hoping this idea could bring revolution in industries and benefits for all [5].

However, in the light of current circumstances, it is important to note that implementation of lean manufacturing has gained momentum. Statistics show that it is implemented in many areas of industries [1]. About 31% industries have implemented it on various scales in addition to 8% of industries that are taking training for implementation and about 16% are planning to implement to the technique [1]. As it begins, to apply lean in industry, following things are required: management commitment & learning and change-dedicated staffing [1]. As applying lean is not that easy task but it was noted that after applying lean manufacturing properly the production improvement was 20% in the system for concrete industry [3]. There was inventory problem and a extra storage was also present; but after using electronic information flow system the inventory problem got solved and overall in the system after using VSM there was 92.58% reduction in lead time and 97.1 % reduction in WIP as we can see leans benefits with time hope for its further use in other field [9].

One of the many possible ways to classify a system is based on the layout [20]. Based on the way the machines are arranged, the layout can be classified as product layout or process layout [20]. These layouts have their own limitations which, in some cases, affect the system performance adversely [20]. Lean, as a solution, offers a layout that is highly effective in production & boosts the productivity [20]. Cellular Manufacturing consists of machines that are grouped together based on the operations that are to be carried out [20]. The part families of products are formed & a highly "streamlined" layout is designed & machines are arranged accordingly [20].

Now, when the use & implementation of lean is talked about, it is necessary to note that as per the research, the analysis shows that in any case, 38% work is case study while 32% is conceptual work, 24% is empirical work and rest 6% is survey articles [10]. Other factors like continuous improvement, lead time reduction, current state map, future state map, takt time and waste of transportation are frequently discussed but suppliers' involvement, flexible suppliers, and manpower reduction are given little importance and rest of the attributes are moderately discussed [10]. Based on the study of above mentioned factors in addition to other factors, a theoretical frame-work is then proposed for the application of lean and other strategies to combine push and pull mechanisms, as relevant, to provide the flexibility needed in form 5S, JIT, visual management, waste reduction, SMED, etc. methods are used for mass customization. The conclusion of above actions & strategies that is if the companies are in any situation that can integrate other strategies with lean concepts to increase the efficiency of (M.C mass customization) operations [11].Lean manufacturing is

beneficial for SME's as is for large corporations it reduces, waste, reduces inventory levels, and adds to the competitiveness of the company in national and global markets [14].

IV. SUMMARY

Lean is a tool that is not limited to a particular industry. It can be implemented to any & every field & also, multiple objectives can be easily achieved by proper utilization of lean tools. Fields other than manufacturing like communication, medical, etc. also use lean philosophy for efficient operation & functioning. In medical field, surgical tools manufacturing also needs lean for cheaper and good quality treatment for everyone. The primary goal of lean is the elimination of waste by identifying the origins of this waste in order to increase the productivity & continuously coming up with an improved method; and applying it to have best efficiency of the system. Now efficiency could be defined in different ways; one is production efficiency i.e. using raw material to its maximum extent so as to minimize the waste of raw material. Another form of efficiency is the time efficiency; using pull system i.e. to complete production within the prescribed time which implements just-in-time system producing the exact amount of products required, not more nor less than amount required. Also, lean helps in streamlining the system with continuous improvement & elimination of unnecessary operations which results in saving time, energy, cost for the industry. Lean and agile manufacturing both could be used in different time schedule i.e. as per seasonal demand. Practice of cellular manufacturing is gaining momentum as companies have started implementing automation. 5S is the most widely used lean tool as it does not require any special tool or gadget. This workplace management philosophy has universally proved to be effective. Industries practicing mass production implement six-sigma to decrease the rejection which hinders the increase in productivity. It even tends to decrease the errors that arise from human mistakes using the Poka-Yoke technique.

V. CONCLUSION

The literature review shows that how lean can be used to integrate & operate various functions of an industry. It also helps in revealing the fact that lean is not a one-time process it is process where we invest with an intention of having long time benefits, it is a continuous process. Lean is an all-round development tool that has tons of advantages if used systematically & properly. It needs high level of commitment from upper level to bottom level. Interrelation of the employees within the industry should be trust worthy & their aim should be benefit of the company. Lean is the need of current times & none of the industries can afford to ignore it. It is said that "**a stitch in time saves nine"** & lean serves as this stitch. Implementing a proper tool at a proper time can really saves time, effort, & money of an industry. Compromising the quality for price can be avoided as higher quality goods can be produced at a comparatively lower price. Also, the company's reputation & prestige increases and a benchmark can be set by using lean. Lean also offers an advantage of employee satisfaction as it reduces the work-load on the employee. This helps to further strengthen the bond between the employee & its employer. But one cannot ignore the fact that the implementation of lean is difficult due to many reasons like lack of proper management, rigid mentality, fear of change, improper knowledge, inadequate training, etc. And also the fact that industries throughout the world are working on lean is enough to prove its significance. The relationship of man & machine has, by far, created wonders & lean tends to further strengthen this bond.

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