

# Artificial intelligence in lean manufacturing paradigm: A review

Arun Kumar Sharma<sup>1\*</sup>, Camelia Pinca-Bretotean<sup>2</sup>, Sarika sharma<sup>1</sup>

<sup>1</sup>Genuine research services, Gwalior, India

<sup>2</sup>Engineering and Management Department, Faculty of Engineering of Hunedoara, University Politehnica Timisoara, Romania

**Abstract.** Industrial organisations must now develop and implement novel approaches to operations and production if they are to compete effectively on a global scale. Changes in product development practises and the use of new technologies have occurred. Businesses encounter problems and difficulties as a direct result of the rapid pace of market change. Organisational priorities focus on minimising waste while simultaneously improving quality and cutting costs. Lean manufacturing is an established approach that should be included into every strategic company strategy. Lean manufacturing concept is a revolutionary that aims to increase resource use while minimising waste. Lean manufacturing has been shown to increase plant efficiency and decrease processing times in major manufacturing operations. In the end, industries depend greatly on their capacity to systematically and consistently cope with obstacles in order to increase product value. Therefore, a value-adding framework must be implemented; the adoption of a lean manufacturing system becomes crucial for any kind of business if it is to achieve this level of perfection. This article gives a overview of lean manufacturing their concepts, tools with application and artificial intelligence in lean manufacturing.

## 1. Introduction

Lean manufacturing is a tried-and-true method that should be included into every company's long-term strategy. The production system originates Lean Manufacturing which is an approach and a set of practises for improving the efficiency and effectiveness of production processes. Lean, in a nutshell, is the standard and systematic use of a group of new technological advances in order to enhance production by cutting away with waste in any form. That seeks, on the manufacturing side, to improve the production facility in some manner. Ultimately, the goal of lean would be to provide a better end result. Waste reduction increases the company's value and leads to better products. This means that the company maximises the effectiveness of its usage of available resources. [1], [2].

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\* Corresponding author : [arunresearch88@gmail.com](mailto:arunresearch88@gmail.com)

## 2. Description and History

The beginning of mass production and the industrial revolution could be good times to implement lean manufacturing practises. Civilization has undergone an enormous shift as a result of the technological revolution. Machine-made goods drove down the salaries of rural workers in the early 1800s, and the mechanisation of the clothing industry led to a similar trend. Most businesses took advantage of low-wage women and asylum seekers for inexpensive labour. Even if industrialization has many benefits at the moment, such as lowering the cost of manufacturing for certain items, the time is difficult since employment is unpredictable and because global conditions have changed continually, many residents may find themselves unemployed. Workers who have lost their jobs due to automation are understandably frustrated. Working conditions in early industries were harsh and dangerous. Workers at many industries were at risk because there was no protection around moving machinery or the people who operated it. The accident might have a direct impact on unemployment and financial difficulty during the time when the wounded worker could not count on financial support from either his employer or the government. The plant life throughout industrial revolutions was hazardous because of the lengthy shifts of the day, little breaks, and the constant scent of Sulphur in the air. Many factory employees complained about the long hours and boredom of factory life during the early stages of the industrial revolution. However, the incentives provided by the manufacturing sector encouraged many people to leave farming behind. Working in industry provided an incentive for little investments to accumulate and was less risky than farming, which left people dependent on the conditions [3].

Historically, there have been problems with factory readiness in the early days. Workers could hardly read, so they were confused by written instructions. Most instruction, if any at all, was delivered verbally. Employees usually learn how to do their jobs by watching someone who has done the job for longer. Staff resistance to change has been a concern when trying to standardise on components used across industries. Early manufacturers had to worry about their workers' morale. Many business owners worried that the high wages would lead to a drop in output when workers stopped coming into the office once they had saved enough money. A demand-based pricing structure is employed by several industries, including the textile industry. The early textile factories that used this method successfully established a causal link between labour and progress. In fields like mining, where teamwork is essential, it has failed so far. [4].

The Japanese have made important contributions to the business world and to healthy company cultures by developing and popularising a wide range of instruments for gradually boost productivity (Kaizen tools). While investigating Ford's method of development, Toyota's management concluded that the mass processing system implemented by Ford could not be used by Toyota and so the company renamed itself Toyota and began producing automobiles. The Japanese market was too small and varied for mass production at the time. Small automobiles to high-end luxury vehicles, consumers had varying expectations. Ford's mass production technique relied on innovation rather than customer need. Toyota put a premium on creating a cutting-edge production system. They had to face the trade-off between efficiency and competitiveness and the realisation that they could produce items more quickly, more cheaply, of higher quality, and, most importantly, with more variety by matching the right equipment with the actual amount required and by introducing new machines. The TPS is a collection of trials that resulted in various new ideas. The industrial revolution and Henry Ford's famous assembly line were the beginnings of lean development. However, due to changes in production strategy, Toyota didn't realise the idea until much

later. The Japanese automaker took Ford's ideas and ran with them, emphasising collaboration and getting rid of wasteful procedures. It wasn't until the 1980s that lean manufacturing came full circle, with other manufacturers finally acknowledging Toyota's meteoric surge in efficiency and adopting their concepts with varying degrees of success. [5].

The Japanese were tasked with finding ways to excel in a competitive market. They began studying American production methods, paying close attention to Ford's effective strategies. Toyota was the company that relied most heavily on the search for contemporary practical solutions in order to ensure its own existence. Toyota had to lay off a huge number of workers in 1949 due to a market decline that followed a protracted strike. They pointed out that Japan has different needs from the United States, and that the future would include the creation of compact, inexpensive automobiles. They arrived at the conclusion that all this on its own would eliminate surplus stocks and any quantity, including human potential. This is where the current management technique, JIT/Just in Time, got its start which also named TPS (Toyota production System). [6].

In accordance with JIT theory, many methods were developed, including Kanban, Jidoka, and the Poka-yoke method, which ultimately expanded Toyota's system. The JIT/TPS rose to prominence when numerous Japanese companies went bankrupt during the oil crisis in 1973. The success of Toyota, which was valued by both Japanese businesses and the government, prompted calls for the model to be replicated across sectors as Japan's manufacturing sector gained a competitive advantage over its Western counterpart. It's important to keep in mind that the JIT is what it is today because of the problems it was created to answer, the increased competition it brought about, and the resulting price reductions. Performance, adaptability, and uniformity may all be optimised with the help of today's production techniques, which can be used anywhere in the world. [7].

### **3. Tools of Lean**

A few examples of Lean tools used for quality improvement are include the Pareto Chart, Histogram, Scatter Diagram, and Control Charts.

A more positive and productive work environment may be achieved with the aid of the 5S technique. It would be unusual to discover a dissatisfied Japanese CEO. Japanese individuals never denigrate their organisation. By making constant, incremental improvements and cutting down on waste, Kaizen plays a significant role in boosting service quality and client happiness. Better productivity and output are the direct outcome of a more orderly workplace. All of this may make employees feel very committed to the business. [8]. Among the 5 tools known as 5S, "Sorting" "standardizing the tools," "straightening up the workplace," "checking the tools," and "cleaning up are most important (Sustain).SEIRI is brief for simply Sort Out. Throw away everything unnecessary. Items that are critical should be kept away from public view, to get organized. Employees waste half of their work time going through important papers. Every item should be kept in its specific space without any interference. SEISO means to shine the workplace. The workplace should be kept clean. Clear desk and files. Documents should be stored in their proper folders and containers. SEIKETSU standardization is important. All companies need a set of rules to ensure quality of its employees. Self-Discipline or SHITSUKE principle is a must for employees. Self-discipline is required. Don't wear casuals. First, follow the procedures. Second, do not forget to carry your identity cards to work. It gives feelings of respect and pride to organization. For long-term objectives, lean organizations gain confidence with patience and creativity. This method may help people to come up with problems and become more efficient. They

accept technology and push for change since this is the only way to continue. The most essential element of kaizen is that it is a process of living that helps everybody at the organization to approach everything and perceive areas for improvement in almost everything [9].

The technological JIT and the Jidoka, are the basic components of Lean Manufacturing, identify a single approach to coordinate work that is aimed at systematically applying employees' expertise and to allow the best use of the employee's ability. This system is complemented by other corporate activities, such as preparation for staff to conduct multiple roles, assigning the re-option to employees in order to control output criteria and to perform simple maintenance. The Jidoka is the power to interrupt the operation when the computer senses that a piece is produced without errors, productivity, prices, time of distribution and product variety. These concepts that utilize employees' capacity are placed in a second category. The last category will be composed of the concepts eventually integrated into lean's configuration. In order to build the spirit of kaizen, there must be an atmosphere of constant improvement in the culture of the business as people strive to find a better way to get the job done. Pull techniques like Kanban, as well as lot size reduction, are frequently utilized to lower storage space and inventories. Scheduling methods can help you know how much time and energy you should allocate to your projects. The term kaizen has been introduced to describe a technique for improving manufacturing processes to reduce defects and waste. Just in time (Just In Time) is a technique intended mainly at minimizing the time within a manufacturing system as well as response times from suppliers and to consumers [10].

#### **4. Artificial intelligence and Lean Manufacturing**

Artificial intelligence (AI) helps manufacturers to improve goods and processes by increasing connection between people, information, and equipment. Manufacturers have seen the value in using Lean concepts, and artificial intelligence is a likely next step in productivity improvement. The rise of AI will make human interaction with many industrial processes. In reality, in advanced instances when machinery's speed and performance are greater than human activities, the practical application of artificial intelligence for particular jobs and commercial processes, removes the need to engage people. With self-learning, the quality, lead times and prices of product creation will be improved by AI, which completely changes the workforce management approach. In terms of technology, AI's primary purpose is to optimize the flow of data for continuous improvement. The application of AI may already decrease the expenses of manufacturers by reducing their costs due to greater job performance. The combination of AI and Lean will enable companies to build a new culture that ensures not only improved operations but also a workflow more flexible for workers, as they assumes certain tasks and transitions into other ones. Like the implementation of Lean, the integration of AI in industrial processes will cause significant cultural changes, and therefore, Lean Management must serve as a central part of the process. continual improvement efforts are needed every day. Lean AI may develop processes, by extracting Lean principles as necessary Waste elimination, to remove the dependence of businesses on human participation and efficiency improvement. Lean and AI provide innovative possibilities as business leaders integrate employee experience in the creation of new roles and structure of technology. Although AI lowers the reliance of businesses on human operations, it may undercut its potential advantages if employees are not involved in AI projects, without slowing down or losing production value, AI may perform observations, analyses and solutions. In addition, AI improves the way it handles issues over time, this allows manufacturers to use AI at any level [11].

Organizations seeking to implement lean manufacturing need to study their current processes to a closer completely honest analysis. Research methodology may be more destructive than productive if a business is still heavily reliant on paper or if various digital systems have separated and disjointed data as process improvement is greatly affected by data. Advances in artificial intelligence (AI) applications continue to improve. Some subcategories of AI include Machine learning (ML), Natural language processing (NLP) and deep learning. ML is useful in manufacturing by helping to discover issues in production line and offering suggestions for how to improve. Customer complaint data is examined using NLP programs, for example. Since it's connected to deep learning, the program is able to respond to consumer needs and help customers address problems without requiring human intervention. In a company, where quality and production processes are connected, this is a powerful aid. Customers' complaints tend to be in the area of quality, but production operations are greatly affected if the data has been collected and the issue is detected. When there is more data, the application gets more accurate. Eventually, an application will not only inform current trash, but it may also inform potential causes of waste and provide ideas on how to prevent it. It is not only possible to say which production line is the least efficient, but can go even farther and pinpoint. An AI program eliminates guessing and figures out which choice is better [12].

## 5. Applications

Lean is the term for effective manufacture/operations, it is founded on the customer's fundamental understanding of the value and the constant enhancement in value distribution in order to eliminate any resource needs that are wasted or, which do not add to the value objective. Lean focuses on the protection of products with less effort, with the end goal of offering the consumer perfect value by generating a commodity of zero wastes. This is achieved by encouraging every worker to understand his maximum ability and thereby create the greatest impact possible. The purpose of empowerment is to demonstrate the value for human beings. Human respect goes beyond the end user also and may involve staff, vendors and culture. Lean aims to optimize value delivery for the end user while minimizing waste. Lean is structured for allowing employees to continually develop their jobs to optimize human capacity. Lean leaders endorse this mission by preparing to address challenges. They help employees flourish internally and emotionally and make them happy [13].

Lean manufacturing is easier to grasp with examples since it entails the periodic upgrading of established procedures for the sake of progress., is organized and improved by modern concepts, methods and techniques applicable to particular problems, with the goal of ensuring stability in the activities and reducing the costs. In the implementation of this methodology the biggest motive of any initiative in this industry has a rather positive effect. In the last decade, the relevant model has been successfully implemented by companies in the dairy, medicinal or machinery sectors. Experiences are currently demonstrating that the demand in Lean Production has grown in the past few years across any form of business, even the services market, although a lot of knowledge still exists, particularly among small and large Medium-sized companies. It is impossible for administrators in certain organizations to gain sustainable benefits after introduction of lean. However, the amount of active Lean applications displays that where it applied concerned results are still really good. The absence of confidence is connected to its implementation managers. Opposition to employees and human element takes a particular role in these circumstance's Implementation and maintenances are important. One crucial reality is that several businesses operate Lean methods are being implemented without complete knowledge. Lean application advantages include time-saving, plant distribution optimization and operational changes. The issue is that

these programs are isolated rather than part of a policy and they are implemented by all the company's administrators to constantly develop them [14].

## 6. Conclusions

Lean is a strategy that was developed in a socio-industrial setting but has shown to be incredibly useful for both businesses and their workers, thus it stands to reason that technicians, professionals, and experts in these fields may turn to its concepts. Lean production is the foundation of a culture that has persisted unaltered to the present day in the pursuit of methods to improve the factory's post-works and production lines via increased coordination, involvement, and communication. In this pursuit, quality management principles were used, and there was a persistent emphasis on personal development. Positive development or progress is meant. This mindset emphasises constant growth and development as a means of bettering oneself. Process enhancement calls for continuous iterative changes initiated by staff members. To increase happiness on the workplace, every worker should always be looking for new ways to develop their abilities and work relationships. When AI is implemented interchangeably with human resources, offering a competitive advantage generating meaningful corporate performance much more quickly than either independently. To maintain Lean's viability, the implementation of Lean tools must be supported by a culture shift. For modernization is essential the desire to accept and adopt new ways to do things. Lean is an approach of various quality management tools, techniques and concepts. There are less research focus found by literature on the use of Lean for the entire company so more research focus is needed in this area, finally it is concluded that lean manufacturing has very wide future prospects.

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