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Lean Manufacturing as a Strategy for Continuous Improvement in Organizations

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Abstract

The implementation of lean manufacturing is one of the most discussed and studied topics in management; references are at the business, educational and public levels. However, the changes faced in the fourth industrial revolution generate challenges that will only encounter solution through innovative efforts and industrial improvements as well as a radical change in our way of interacting. In the current revolution, there are digital changes that cause ruptures in social, economic and political aspects, and the administrative process is part of it, this chapter proposes to analyze the implementation of lean manufacturing in the process of continuous improvement in business organizations through a literary review of the implementation of tools.

Keywords: continuous improvement, industrial revolution, digital, lean tools, high quality, globalization

1. Introduction

Despite being in many fields, organizations continue to be the spearhead in the innovation process. In the competition to produce high quality, low cost products, industries want to be more agile and faster. The environment of modernity forces companies to compete in markets outside their national borders, it is itself part of globalization, which as we know has played a very important role in the development of international finance. Multinational companies have managed to position themselves as one of the engines of the economy, coexisting in complex and heterogeneous environments.

In the search for quality, there is a fierce competition of globalization; organizations have invested in the development of knowledge and technology, improving already established processes. However, progress has not been homogeneous in all areas.

Lean manufacturing implementation is more important in some areas, as different tools are used to benefit the company and its employees. Some of the benefits include: reduction in production costs, reduction of inventories, reduction of delivery time (lead time), better quality, less labor, greater equipment efficiency, reduction of waste, overproduction, time of waiting (delays), transportation, inventories, movements, poor quality, among others.

2. Origins of lean manufacturing

Lean Manufacturing has its roots in the Toyota Production System originated at Toyota Motor Company by Taiichi Ohno and Shigeo Shingo [1]. It focuses on developing high quality, low cost products using less time, less space, fewer workers, and fewer tools.

After the First World War, Henry Ford and Alfred Sloan (General Motors) changed artisan manufacturing – used for centuries and directed by European companies– for mass manufacturing. Largely as a result, the United States soon dominated the world economy [2].

In 1950 Eiji Toyoda visited Ford's Rouge plant in Detroit for three months, an uncle had visited it in 1929. The Toyota Motor Company was founded in 1937. In 1950, after 13 years of work and effort they produced 2,685 automobiles, compared with the 7,000 they produced daily.

According to [3] Toyota's way of achieving a "lean" approach was to eliminate all waste, that is, activities that do not add value to the product from the customer's point of view. This allows reducing costs and increasing productivity. However, waste disposal is not enough because it requires a context and a culture, known and understood by all stakeholders (senior management, collaborators and suppliers). The Toyota way in a model is in a pyramid representing Toyota culture from top to bottom. This is the 4P model: 1) a philosophy of long-term thinking; 2) continuous process improvement to eliminate waste; 3) People and partners respect, challenge and grow; 4) Problem solving through continuous improvement and learning.

To locate the origin of the word lean, it is necessary to name JP Womack, and Daniel Jones, two researchers from the United States and from England, respectively, who are referents in this matter, through their work entitled "Lean Thinking" managed to concentrate the fundamentals of thought 'lean' and the concept of waste ('muda'). They also managed to perfect the concepts of value stream, flow, pull, among others.

Currently, a company that does not consider the implementation of this system is not in a position to compete in the world, since it will be absent from aspects such as the quality of products and services, reduction of operating costs and the subsequent increase in sales. However, to find the right tool it is necessary to carry out a detailed analysis of the company's conditions.

It can be said that this system places a company as a world-class one, since it carries out procedures that guarantee productivity, efficiency and the quality of products and services. In addition, several previous works confirm the benefits of implementing this system.

In the study [4] many factories reported positive results with the implementation of lean manufacturing. Some of these benefits are improved quality, high inventory turnover, and productivity increases. All these benefits lead to greater customer satisfaction and loyalty, and higher profits, in addition [5] comments that one of the most important criteria of this system is to get rid of unnecessary issues in manufacturing that do not add value to the product.

We observe in [6] the current situation in the implementation of lean practices in manufacturing plants in India and its impact on operational performance. The study was conducted by applying a questionnaire to 79 plants in different regions from India. Lean manufacturing is a multidimensional construct, finding that 80% of the plants have implemented various dimensions of lean manufacturing; such as focus on the needs of the customer, pulled production systems, reduction of exchange time of molds (SMED), total productive maintenance (TPM), relationship with suppliers, statistical control of processes and inclusive problem solving.

It was also found that productivity, quality at first intention, reduced delivery time and inventories, as well as occupied space, in summary, respondents stated that quality at first intention, reduction of time delivery and increased productivity are the top three drivers of lean adoption in that context.

Finally [2] finds that the constructs of lean, sustainable manufacturing and continuous improvement have a direct, relevant, positive and statistically significant impact on the dependent construct.

3. Lean manufacturing challenges

The fourth industrial revolution or revolution 4.0 is the product of the innovative efforts of the previous revolutions. Without a doubt, this phenomenon not only generated industrial improvements but also changes in the way of interacting with each other. Series production, electricity, transportation, are just a few examples of progress. In the current revolution, digital changes arise that cause ruptures in social, economic and political aspects, and in this sense, the administrative process is part of it.

In light of the technological developments associated with the revolution 4.0, the relationship between lean manufacturing and technology has once again become an area of research interest [7, 8].

The fourth industrial revolution promises to change the manufacturing landscape, and those who cannot take advantage of new technology-induced opportunities are destined to lag behind their competitors. An important area to investigate is the role that lean manufacturing will play in this new industrial age [7].

Lean manufacturing as a system is possible with various subsystems (tools), which are used to reduce and eliminate waste in companies. The right tools that help to eliminate all the waste and all the operations that do not add value to the product or to the processes, is the last aim of this system.

The challenges of lean manufacturing, especially in small and medium-sized companies have to influence the integration of the lean culture within their vision, develop leadership based on that culture. It is necessary to deploy that culture to everyone in the organization; involve the entire management team; have well-defined plans; know very well what processes contribute and which ones do not add value; and finally make this culture your day to day.

Below we give an account of the identification tools used in this system and we delve into the innovation of manufacturing, ending our analysis with the culture of quality.

The production systems related to a product or service must be analyzed under the approach of a value chain, which implies showing all the related activities to identify those activities that do not add value and that are classified as waste according to the manufacturing philosophy. Lean, which provides us with a series of tools that must be carefully selected to apply the most appropriate to eliminate waste and improve flow, as well as productivity in these production systems [9].

4. Importance of sorting waste according to the lean manufacturing philosophy

It is essential to know the types of waste that lean manufacturing proposes, also known as “Muda” due to its origin in Japan in the Toyota production system. Waste is anything that is not absolutely essential for production. Lean

Manufacturing identifies the following seven types of waste that must be eliminated in a production system [10].

Overproduction. Process items earlier or in greater quantity than required by the customer.

Wait time. Products or goods that are not being transported or in the manufacturing process are on hold.

Transport. The handling and transfer of materials or documents that do not add value are considered wasteful.

Inventory. Excessive storage of raw material, product in process and finished product.

Over-Processing. It is about adding unnecessary steps in work activities and not required by the client.

Movement. Any movement that the operator makes apart from generating added value to the product or service.

Defects in the process. Repetition or correction of processes also includes rework on non-conforming products or products returned by the customer.

Once the activities of the process where some type of waste is being generated have been classified, it is necessary that all the employees of the organization participate by undertaking specific actions for the elimination, for which the managers must promote an environment that promotes the generation of ideas and the continuous elimination of waste. In addition, it is important to train in the different tools, techniques and methodologies that lean manufacturing relies on and to establish a deadline to verify the results.

It is necessary to note that the full identification and elimination of waste has become a pillar for companies, when deciding absolutely on the use, investment and management of their resources, which is essential to find opportunities for improvement in the organization and achieve greater process efficiency [11].

5. Top lean manufacturing tools

The lean manufacturing tools that are mostly used in the industrial sector to increase productivity are the following: [12].

5S is a tool focused on working with effectiveness, organization and standardization. It is used to improve work conditions, through the organization, classification, cleanliness and order in the workplace. It seeks to establish a pleasant and high-performance work environment that allows the correct performance of daily operations [13].

According to [14], **Kaizen** is a Japanese word that means continuous improvement and presents a methodology to improve any production process through the implementation of different techniques, tools and methods, in addition to promoting a cultural change, teamwork, skills development and initiative to identify root causes of problems.

Poka Yoke seeks to prevent the production of defects caused by humans when they make mistakes in their workplace, blocking or stopping the process in case of failure [15].

Andón is the signal system that allows showing the state in which the machine is (running, stopped, stuck, etc.) [15].

SMED Single-Minute Exchange of Dies Set of techniques that seek to reduce machine setup times, Standardization through the installation of new mechanisms, templates and functional anchors, eliminates downtime adjustments [15].

TPM Total Productive Maintenance Set of techniques aimed at eliminating breakdowns through the participation and motivation of all employees, maximizing

effectiveness and lengthening the life of the equipment and preventing losses in operations [16].

Kanban is a tool that helps to improve the production flow in a line through “labels”, which serves as a “work order, informs in a timely manner what is going to be produced, in what quantity, by what means, and in what will be transported.

Jidoka Technique based on the incorporation of systems and devices that give machines the ability to detect failure in production.

Heijunka is key to achieving flow and leveling in production, the purpose is to level the production schedule by sequencing the orders according to a repetitive pattern that makes the average daily production similar between the different days of the week [16].

MUDA type	Lean Manufacturing Tool
Overproduction	<ul style="list-style-type: none"> • Kaizen (improvement event, work teams) • VSM (mapping of cycle times in production processes) • Heijunka (level production) • SMED (reduce setup times)
Timeouts	<ul style="list-style-type: none"> • Kaizen (application of the methodology for the proposal to reduce waiting times in the value chain) • VSM (identify and adjust lead times in production) • SMED (reduce waiting times in machine preparation) • Jidoka (automation with presence)
Transport	<ul style="list-style-type: none"> • Kaizen (continuous focus on improvement and improvement of logistics processes) • VSM (identification of transports in the different stages of the process)
Inventory	<ul style="list-style-type: none"> • Just in time (eliminate all inventory that represents waste in purchasing, manufacturing, distribution activities) • VSM (transfer of raw materials and finished product. From supplier to plant or from plant to customer. • Andon system (visual control of inventory levels) • Kaizen (kaizen event to improve inventory system) • Kanban (level the flow of materials)
Over-processing	<ul style="list-style-type: none"> • Kaizen (kaizen event to eliminate unnecessary steps in work activities) • VSM (process mapping to identify activities that do not add value from the customer’s point of view)
Unnecessary movements	<ul style="list-style-type: none"> • 5 s (organize work so that unnecessary movement is minimized, ensures work areas are consistently clean and organized) • VSM (identify on the map the movements that are found and that do not add value to the client)
Defects	<ul style="list-style-type: none"> • Poka-Yoke (Anti-error system) • Jidoka (automation with people control) • Kaizen (continuous improvement proposal) • VSM (value chain mapping to identify defects) • Kanban, 5 s and Andon System (Visual control) • TPM (preventive maintenance plans)

Table 1.
Lean manufacturing tools for Mudass removal.

JIT Just in time. This system consists of getting the parts necessary for assembly to the line at the right time they are needed and in the right amount required.

VSM Value Stream Map is important to manage the entire value stream for each product, in order to understand where waste occurs, rather than looking at activities or processes in isolation. Therefore, a value flow map must be created where each of the actions required to design and manufacture a specific product is clearly identified.

Activities that create value from the customer's point of view; as well as those activities that do not create value from the customer's point of view, cannot be eliminated. They can be improved in order to reduce the time that they are given, and finally the activities that do not create value from the customer's point of view, and that are unnecessary, and these can be eliminated immediately [17].

The implementation of quality tools in a lean production system is strongly linked to common sense, and that is why adequate preparation in the organizational culture must be required, where both managers and employees have the commitment to change their traditional ways of thinking and working [18].

If there is not clear identification of the different quality tools that are applicable for the elimination of the different wastes, then no efforts aimed at improving the production processes will have the expected impact. That is why as a contribution to this work, **Table 1** shows the different changes and the lean tools that may be appropriate to solve these problems were identified.

6. Three IT (information technology) innovation trends impacting lean manufacturing

According to [19] one of the industries with the greatest global impact is the manufacturing industry, in which there is high competition worldwide. Therefore, he recommends that companies become aware of the transformation they must have in three areas: Internet of things (IoT), Smart factory and Personnel management.

6.1 Internet of Things (IoT)

Within the manufacturing sector, identification devices such as RFID (Radio Frequency Identification) or RTLS (Real Time Location System) are key to optimizing and planning process automation [19].

6.2 Smart factory

More and more companies are interested in adopting digital approaches in their processes to optimize costs and times. One of the great transformers in the sector is business software that integrates processes, since they help improve the profit margin or reduce machine downtime. An example is ERPs (enterprise resource planning system), which benefit the generation of proactive analysis, the reduction of errors or the monitoring of payments and collections [19].

In Mexico, 5S's application software was for MSMEs with the aim of being an engine of change towards continuous improvement [20]. Transforming the way of carrying out day-to-day operations in the MSME field is the innovative contribution that is intended to achieve it with the development of a 5S's application software. An improvement to the software is considered by adding four more S's, Shikari, Shitsukoku, Seishoo and Seido (Constancy, Commitment, Coordination and unification through standards); that is, implement up to 9S's in companies. Likewise, the 5 W (5 why), poka yoke and visual control tools can be developed in the same software.

The implementation of the 5S tool in all SMEs, aims to eliminate waste and ensure a clean and orderly work environment. The results of the application of this lean tool in SMEs are immediate, the result is a great visual impact, avoiding customer complaints, improving staff participation and improving process efficiency [21–23].

6.3 Personnel management

The manufacturing industry is one of the most questioned when it comes to staff turnover. The sector must be more sensitive to the importance of retaining the best-qualified workers because their potential generates greater competitiveness. It invests in the training, promotion and well-being of workers. It also detects areas of opportunity and improvement in the functions they perform within the organization [19].

According to [24] successful innovation requires a strategic and tactical deployment in the organization, integrating the commitment, resources, capabilities, and joint efforts of the different dependencies of the company, from senior management to operators. This includes engineering, research and development (R&D), production, marketing, merchandising, finance, human resources, and other functions.

In the context of lean manufacturing and its multiple tools, continuous improvement is immersed (**Table 2**). This is a key element in quality standards and processes. Currently in the quality culture of companies, the main standard is precisely continuous improvement, whose philosophy has permeated in various sectors around the world. A typical example is the Japanese companies, which lead the application of the tools of lean manufacturing, quality management and continuous improvement. This work methodology is about the Toyota Company, which is currently a

Tool	Basic purpose	Preliminary targeting	Method
Strategic tools	Strategic innovation tools are mechanisms that the company uses to analyze its internal resources and capabilities and external threats and opportunities.	Company strategy, useful for the entire organization. You get a SWOT of it.	A matrix is completed that gathers the characteristics of the organization and the behavior of the environment for the businesses developed.
Creativity	They are mechanisms that the company uses to promote creativity and promote the flow of ideas. Creativity is used either for the search for creative solutions or for the design of new products.	All the company.	Carry out a creativity session through brainstorming.
Technological surveillance	Know the main trends in the environment and technological leaders, in order to make decisions.	Company strategy, useful for the entire organization.	Databases or patents are analyzed and processed and in the end a technological map with different clusters is obtained.
Organizational capacities analysis	Know how the organization's capacities are in innovation, external and internal, to take improvement measures.	Company strategy, useful for the entire organization.	Apply a questionnaire and in the end different graphs are obtained where the capacities are measured.

Table 2.
Tools related to innovation.

model to follow in lean manufacturing since it achieved a balance in the combination of strategy design and operational excellence.

Some of the tools mostly used in companies, aimed at the operational area are 5 s (Seiri, Seiton, Seiso, Seiketsu, Shitsuke), which is applied in companies basically to avoid waste, improve performance and efficiency and thereby improve productivity in the workplace. SMED (Single Minute Exchange of Die), its usefulness in the processes is to reduce the change time and increase the reliability of the change process itself. TPM (Total Productive Maintenance), focuses on managing the maintenance of the company in order to maintain zero failures, here all personnel and all phases of the production process are involved. Kanban serves to identify the material requirements made in the production process [25].

JIT (Just In Time) tools, which originated with the purpose of eliminating inventory, are also widely used, in addition to other diagnostic and monitoring tools, automatic stops, takt time, level production etc. These tools originally created in the Japanese automotive industry, with a notable deployment to other sectors of the maquiladora industry, but especially in other areas and in small or medium-sized companies around the world.

In summary, lean manufacturing has triggered a series of steps that allow a true adherence to excellence, among these steps is continuous improvement, the objective of which is to achieve standards and good quality management. In this sense [26] mention that the starting point for companies is to have an organization focused on the client, understand current and future needs and try to satisfy them. Another essential aspect is having excellent leadership through which the staff is involved and thereby enhances the participation of different levels and areas of the company, which translates into a high level of commitment.

In the culture of quality, emphasis is on the focus on systematized processes directed towards quality management. These aspects result in a constant evolution towards quality and lead to efficient decision making that benefits both the forward processes, that is, with the client; as backwards, that is to say with the providers; thus achieving a convergence in all the processes involved.

Historically, there have been great companies and brands that have made revolutionary contributions to quality. Proof of this is undoubtedly Ford Motor Company, American Telephone & Telegraph and Western Electric, whose processes initiated the implementation of quality criteria in various areas, not only in production. On this same subject, the participation of Japanese companies has been more than relevant, since in addition to Toyota, "Company Wide Quality Control" was created, which involves all the resources and processes existing in the company, thus achieving what is called "total quality" [27].

On the other hand, in Europe there is the "European Foundation For Quality Management" that synthesizes its quality model in the satisfaction of customers and employees through leadership that promotes policies and strategies of the organization. Along with an adequate implementation of the resources and above all a perfect management of the most important processes in the organization to obtain excellence in results [28].

As for the Latin American region, there are also records of the implementation of lean manufacturing tools as a strategy for achieving quality. In the study [29] analyzed Mexican and Colombian companies, and applied an instrument where they were asked, among other things, how often they use tools for quality management. The responses showed a clear trend towards use in managerial positions and from middle to senior management onwards. What is interesting about this analysis is that it focused on small and medium-sized companies, which makes it clear that the culture of quality has permeated not only in various areas, but also in companies from different sectors.

In summary, lean manufacturing provides great benefits to companies by eliminating waste, processes that do not generate value and that make administration bureaucratic and expensive. The new projects seek to be born in the context of continuous improvement and quality culture, and on the other hand, existing companies make great efforts to incorporate these work methodologies, seeking as their main purpose the reduction of operating costs.

It is clear that the adoption of lean manufacturing is on the way towards efficiency in the processes of the main line of business of companies. It is evidently focused on permeating the organizational culture in order to transform the competitiveness of the company; and thus be more attractive to shareholders, employees, suppliers and customers. Every time of a demand of better conditions not only in the products, but also in the prices, response times of the company, the commitment that it shows on social responsibility and environmental responsibility; and in general in the image that is projected towards the market [30].

For companies to have the ability to respond to the new and increasingly demanding market requirements, the decision to adopt the culture of quality is necessary first. It corresponds to managers or owners of the companies, probably encouraged by the workers themselves who are in the operational area and know and experience the problems that carry out their work in a daily way.

A part of special importance in such a large organizational change is to establish, provide and promote the appropriate conditions for the development of this type of project. Carrying out an organizational transformation entails re-educating all the parties involved. From suppliers, at the time they are requested to implement computer systems that make deliveries just in time and without defects, through production that must focus on zero errors, zero waste and zero delays, encouraging real production cost calculations and exact, documentation, improvement and control of each of the processes, as well as efficient and effective management of resources. All the departments that together make up the company must also be involved, that is; continuous improvement and lean manufacturing must permeate the entire organization.

These business transformations must emerge from the organizational culture itself, it does not mean a change of personnel to generate new uses and customs, but an evolution in the way in which business processes are carried out, trying to reduce the maximum movements and the number of processes and transactions carried out to achieve production.

Among the main elements of the culture of quality, it is suggested to bear in mind that perfection does not exist; however, processes can work in a harmonious, uninterrupted way and with immediate error detection to avoid waste and rework. It is important to have an open mind that socializes the information openly, and above all to talk and share problems as well as opportunities for improvement, for example holding kaizen events where problems are analyzed to obtain holistic resolutions that involve the entire company.

Another essential aspect in the culture of continuous improvement is to instruct workers to maintain a dynamic based on learning, which is also systematized and is not linked especially to one person, but to the work team in general. This is important given that when a problem is studied and all parties participate, each department exposes its intervention in the analyzed process and the way in which they can intercede to improve and at the same time reduce the amount of processes, costs, and waste that were generated.

Once this open culture is established, the next level is to encourage accompaniment to support people in the development of their processes, and remain receptive to the emergence of new ways of doing things, accept, adopt and adapt changes that generate added value, lower costs and provide greater agility in deliveries. It should

not be forgotten that in lean manufacturing there are four important parts that must be coordinated to achieve perfection in the systems. According to [31] the starting point is the design and engineering of the product, the supply chain, the demand and the customer.

The design is based on teamwork made up of members who come from different departments, with experienced leaders who encourage effective and respectful communication, where all participants must express acceptance of the decisions made, with the aim of that differences and conflicts are exposed at the beginning of the projects and not afterwards.

On the other hand, companies require excellent coordination in the supply chain to have access to good quality materials, with fair prices and in a timely manner. In the lean philosophy, functional levels are proposed and each of them has its own responsibilities. The first level is the integral part of the design and development of a new product. The second level is where the necessary parts are supplied. It should be borne in mind that lean manufacturing considers the customer first as the guiding principle of what to do. Therefore, companies must adapt to the market and the constant transformation of demand.

It is worth mentioning that every day the market and with it the demand, tastes and preferences of consumers continue to globalize. This fact has led small companies to incorporate lean manufacturing practices since to be part of the global value chains of the production systems of large companies (transnational, multinational, international and global), the main requirement is the management of quality demonstrated from production under standardization.

In this increasing integration, it is impossible to go back and regionalize production since supply chains are interconnected globally, which means that production is also global. In this sense, it is urgent, especially for micro, small and medium-sized companies, to join what has also been called the Toyota house, whose main objective is excellence in operations [32].

The key piece of this transformation is undoubtedly a human talent that enjoys commitment, academic training, professional experience, communication and leadership skills and with sufficient motivation to direct their efforts towards the realization of stable and standardized processes that result in a level production, always working under the motto of continuous improvement.

7. Conclusions

This chapter reviewed the application and integration of lean manufacturing tools in a current perspective, emphasizing the continuous improvement, detailed analysis of the current state of the process, and identification of a reliable starting point; in addition to the commitment of employees and management in the stages of planning, monitoring and taking actions.

Finally, it becomes clear that lean manufacturing increases quality and productivity in companies by reducing waste and therefore production costs; adapting favorably to the different innovation systems that are required today; and it enables the establishment of a continuous improvement work methodology that invites the constant review of processes and consequently the culture of change and quality within companies.

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