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Organizational Control Through Lean Manufacturing

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Abstract

Industrial companies are in a constant search for competitiveness, so they need to develop strategies that allow them to sustain over time, offer quality products and get the most benefits from their production system. It is necessary the application of a methodology focused on continuous improvement, where Lean Manufacturing stands out, which provides companies, the use of its resources, contributes to optimize productivity and ensures the quality of products to meet customer needs. It is for this reason that this research presents theoretical and conceptual contributions on this methodology, in order to extract important aspects on the benefits it brings to the production system such as the elimination of waste. In addition, to examine publications on companies that have implemented its tools and to know the results in the solution of their production problems, in which it was found that most of them use the tools: 5'S, Kaizen, Kanban and SMED, since they give solution to one of the most recurrent problems such as reprocesses, dead times and unnecessary displacements.

Keywords: Lean Manufacturing, Continuous Improvement, Productivity, Quality, Waste Elimination.

1. Introduction

Globalization is a phenomenon of constant fluctuations that lead companies to be in a highly competitive environment, which encourages the industry to seek mechanisms and strategies in order to sustain itself over time, develop quality products and satisfy customer needs strategies in order to sustain itself over time, develop quality products and satisfy customer needs. Therefore, they need to continuously improve their production processes by reducing operating costs and complying with international standards and environmental laws to effectively manage the use of resources. Ensure sanitary conditions and have a positive impact on the community within a sustainable development framework.

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For which it is required to efficiently and effectively develop their activities, as this will allow them to obtain competitive advantages, which will be translated into better products and services for their consumers, as well as a better environment for their internal customers and generation of value for shareholders (Rojas & Gisbert, 2017). For this reason, the organization must develop a new corporate culture, where through existing resources, it can prepare to compete, and this not only refers to the generation of more sales, but also to offer quality products, which generate value and competitive advantages, offer better prices and a shorter response time. Thus, companies must implement different strategies, in order to direct their company to obtain better results, so they must take the most appropriate tools to give the organization the efficiency and productive effectiveness required to be competitive.

In this case, the Lean Manufacturing methodology is a management tool that every organization should carry out for the continuous improvement of its processes. This method, also known as "lean production", is a method oriented to the elimination of waste, being all those activities that do not add value to the product, but increase its costs and therefore its value. Lean Manufacturing, in turn, has seven tools such as "TPM, 5'S, SMED, Kanban, Kaizen, Heijunka and Jidoka", methodologies intended for the production of automobiles in Japan, more specifically in the Toyota company. However, their positive results gave applicability to a variety of processes other than this one.

Lean production is a systematic model that allows identifying critical points and eliminating excessive behaviors that occur in the production process, and these behaviors imply unnecessary work (Malpartida Gutiérrez, 2020). This methodology, conforms teams dedicated to a strategic approach, which, through the observance and analysis of the processes, and an effective use of resources, optimize the production process, taking from them, opportunities that directs them to continuous improvement. This can be achieved by defining the value of the product, standardizing the process, creating continuous flows, creating a system focused on customer satisfaction, striving for perfection and quality of products (Malpartida Gutiérrez, 2020). This methodology can be applied throughout the production chain, i.e. in each of the stages that compose it, waste can be eliminated, costs can be reduced, quality can be improved and operational flexibility can be achieved.

Lean manufacturing is followed by companies that want to improve competitiveness and achieve better results while using fewer resources. One of the aspects that companies are most concerned about is "high competitiveness", so those processes that provide added value are essential to configure competitive advantages, that is, a process that can reduce production time and increase efficiency. And this is one of the objectives of Lean Manufacturing, which is to eliminate all activities that do not add value throughout the production process and that, in turn, can reduce production time and increase efficiency. This can be considered an advantage both for the industry and for society in general, as it has implications in cost reduction, prevention of penalties and a lower environmental impact.

The application of this methodology has a great impact on the control of production, inventory, time, products with quality problems or defective products, waste, unnecessary movements, transportation and labor overload or staff capacity. And it has a fundamental approach, and are the cultural changes that it generates in an organization, which gives a twist to its business philosophy, which emphasizes the human resource as organizational wealth and the factors that motivate them as the main success factors (Tejeda, 2011).

Thus, being this methodology fundamental for process control, this research focuses on a bibliographic analysis, under the compilation of concepts and tools on Lean Manufacturing in production lines, with the aim of expanding the panorama of application of this methodology, and how this, in turn, can

increase or improve production efficiency. Subsequently, the background of the Lean Manufacturing methodology is discussed, showing how it emerged and how it has become one of the most important methodologies for solving problems in production systems, as well as the compilation of the main results of the applicability of this methodology in different companies, in order to establish the importance in solving problems of a productive nature.

2. Background

Lean Manufacturing, is known as lean, which refers to productive improvement and optimization, whose focus is to make them more efficient, reduce costs and waste (Orozco, Cuervo and Bolaños, 2016). This term was initially used by "...John Krafcik", when explaining that "lean" refers to concrete, precise or lean production, because it uses fewer resources, comparing it to mass or large-scale production (Vargas, Muratalla, & Jiménez, 2018, p.5).

In the vicinity of the twentieth century it was evident the development in various sectors of the economy, the concept of mass production, conceived and developed in the automotive sector, which found in Taylorism and Fordism, its maximum exposure. But this not only referred to the manufacture of products in large volumes, but also encompassed a fairly broad system of markets, technologies, economies of mass production or scale and inflexible rules. Taylorism, according to Bounine, was the proponent of the scientific method of division of labor, chain production, and the elimination of control or autonomy that the worker had over how to develop his work, but that, in the long run, did not get the expected sales because it increased production cycles and inventories (Bohórquez, 2015), because, after the division of labor in each company, area or department, each one went after a specific achievement without seeking the optimization of the production process as a whole (Figueroa, 2016). This production system was no longer feasible, and was sheltered by the depression in the United States, a crisis generated by overproduction, by underconsumption, i.e. production exceeded the purchasing power of society. Reason Henry Ford developed manufacturing chains and controls, introducing machines for the development of tasks, simplification, sequences, routes, process synchronization, and work specialization (Bohórquez Días, 2015).

However, despite these measures, at the end of the sixties, Rajadell, mentions that the model ceased to produce the expected effects, therefore, productivity decreased and fixed capital increased, which generated a reduction in profitability levels; at this time the model so far developed had to come to an end, and needed a change (Bohórquez, 2015).

The change of these techniques was evidenced in Japan in 1902, and it was there where the first signs of the Lean Manufacturing methodology began to be seen. Sakichi Toyoda, was the creator of Toyota Motor Company, who invented a control or alert system, by means of a device that stopped the machine and when a thread broke it was a signal that it required monitoring; this helped the operator to effectively control several machines, and it is through this, where the need to develop new working methods arose (Bohórquez, 2015). In addition to this, Toyota Motor Company, like many companies, went through the ravages of the Second World War, and little by little they were building the competitiveness of their markets, in this way Japan took advantage of the material resources that they themselves could supply, thus achieving a productive optimization without developing a large-scale economy. Thus, under this alternative, in 1950, a group of experts from Toyota Motor Company, headed by Eiji Toyoda and Taiichi Ohno observed for three months the Ford Rouge company in Detroit and concluded that one of the main problems in the production process was the waste (Bohórquez, 2015) and that they could not develop the large-scale production process developed in that company, since the market they handled in Japan

was not equal to the volumes of Ford and General Electric, which led Taiichi Ohno and Eiji Toyoda to develop a new production approach (Tejeda, 2011).

Thus, in 1973 after the oil crisis, Toyotism and the lean production method, which came to replace Fordism and Taylorism, spread (Bohórquez, 2015). Hand in hand with the development of the "rationalization of the work process", the minimum manufacturing process was created, based on "the reduction of stocks of materials, equipment, etc., and complemented by the principle of the flexible factory based on the allocation of production operations to obtain a continuous and rapid flow of response to market demand" (Bohórquez, 2015, p.5). Toyota's model is summarized in the following points:

1.Eliminate waste.
2. Supply in a timely manner the materials and inputs for production.
3.A relationship of trust and transparency with suppliers, where long-term commitment and collaboration is a priority.
4.Active participation of the collaborators in decision making, such as stopping production if necessary, intervening in preventive maintenance tasks, and contributing ideas or suggestions that allow the continuous improvement of the processes.
5.The foundation of total quality consists of eliminating defects in the shortest possible time and as soon as they are detected, implementing elements or techniques where quality is verified at all times.

Under this background, the Lean Manufacturing method was initiated, oriented to a new way of developing production processes, eliminating unnecessary activities in the manufacturing area, benefiting the economy of the whole world.

3. Method

The methodology of this research article was developed through a search in Google Scholar, ScienceDirect and Scielo databases, with a ten (10) year observation range and the keywords: "Lean Manufacturing", "productivity" and "continuous improvement". The following inclusion criteria were taken into account for the debugging of the information: a) to identify the works relevant to the topic, taking into account a time range of ten (10) years; b) to select the works, among articles and degree projects related to the topic and c) research that addressed topics on industrial engineering, continuous improvement and processes and tools focused on Lean Manufacturing.

Once, having clarity on the research criteria, the collected information was filtered, verifying those pertinent and relevant topics related to Lean Manufacturing, continuous improvement, processes and productivity. As a result, a total of sixty-eight (68) articles were obtained, of which fifty (50) were selected, which showed direct relation with the topic of study, on concepts and contributions of authors, which allow to fulfill the research objective, being to identify the importance and implications of the Lean Manufacturing methodology in business productivity. These documents were included in the Background Matrix.

4. Results

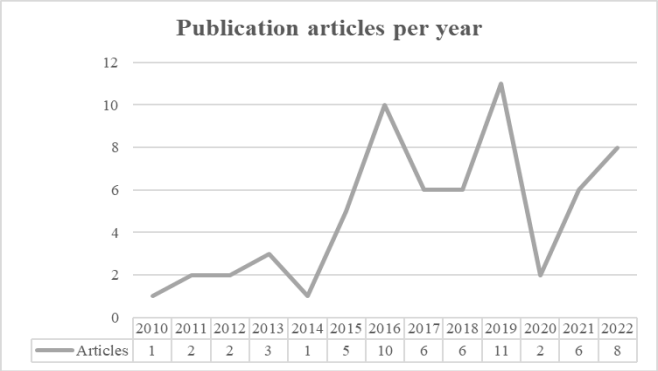
Based on the bibliographic review of the Lean Manufacturing methodology and its importance for productive improvement, the results and analysis of the information are shown in four sections: a) research trend on Lean Manufacturing, b) theoretical and conceptual contributions on Lean

Manufacturing, c) identification of the main tools that make up Lean Manufacturing and d) results in the implementation of Lean Manufacturing tools in the industry.

4.1 Research trend

In this section, a classification of the research was made, taking into account the articles published per year, per country, and studies per sector. Figure 1 shows the research carried out in the last ten (10) years on Lean Manufacturing.

Figure. 1. Publications per year.

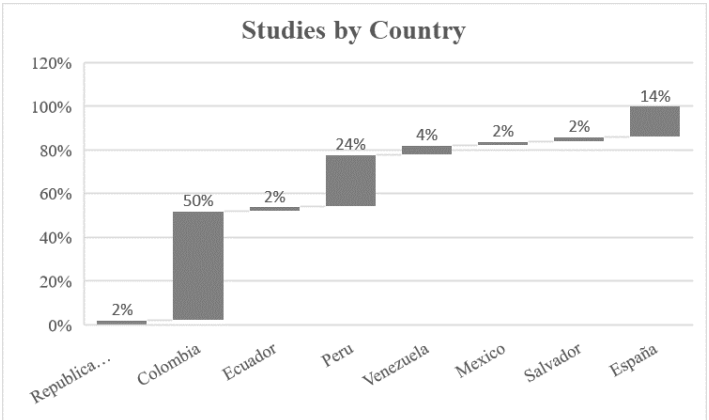


Source: Own authorship.

The information shown in Figure 1 shows a fluctuating panorama of research studies per year. From 2010 to 2014, a low number of research studies is observed, while from 2015 there is an increase in the number of studies, with a higher volume in 2016 and 2019. However, it can be said that during 2017 and 2018 the number of publications decreases, but this does not mean that there is no information on Lean Manufacturing, but rather that during those years there was a different approach to this methodology, and it did not meet the search and application criteria for this literature review.

Likewise, this information shows that, at present, Lean Manufacturing has become a methodology of utmost importance, given the growing competitiveness and the need to sustain over time, has made more evident the importance of implementing tools that allow an organization to continuously improve its processes, and thus, to produce quality products and satisfy the needs of its customers.

Figure 2. Studies by country.

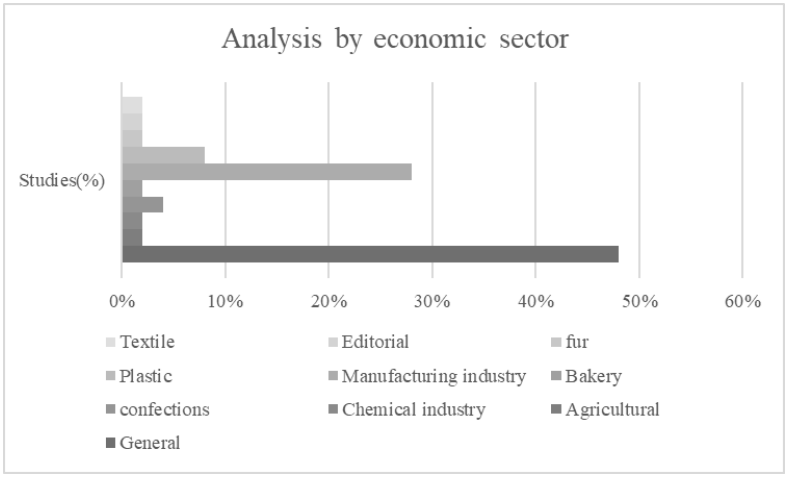


Source: Own authorship.

In relation to the study by country, it can be observed in Figure 2 that, according to the search criteria and filters applied to the information, eight (8) countries presented research or studies on Lean Manufacturing. Likewise, it is evident that in countries such as Venezuela, Dominican Republic, Ecuador, Mexico and Salvador, there is less interest in developing research related to this methodology.

Figure 3, on the other hand, classifies the different researches on Lean Manufacturing taking into account the sector of application. In 48% of the research, the authors focused on documentary and bibliographic research on the research topic, collecting substantial contributions of this methodology without highlighting a particular sector; 52% of the works consulted, the authors focused on manufacturing companies in which abrasives, cylinders, steel mills, auto parts factories, valves, foams, and machining companies are grouped in the same line. In addition, companies producing plastics and clothing, while agricultural production, chemical, bakery, leather, publishing and text are the least investigated sectors, thus having a field of action for the development of further research. It is evident that the manufacturing sector has integrated studies on the subject, given its importance for productive improvement and competitiveness.

Figure 3. Studies by sector.



Source: Own authorship.

4.2 Conceptual and theoretical contributions on "Lean Manufacturing"

Under the bibliographic research, it was possible to make a tour of the origins and beginnings of this methodology, embodied by different authors that show that the term Lean Manufacturing also known as Lean Production, a term introduced by John Krafcik and embodied by two important books "...The machine that changed the world, by James Womack, Daniel Jones and Daniel Roos; and Lean Thinking, by James Womack and Daniel Jones" (Vargas, Muratalla, & Jimenez, 2016, p.6), a term that has its beginnings in the Toyota production system, as discussed in the background. Lean Manufacturing, translated into Spanish means lean, which, applied to the productive system, leads to an agile, flexible and practical system, with the ability to adapt and meet the needs of the consumer (Vargas, Muratalla, & Jimenez, 2016). Other authors, focus the concept of Lean Manufacturing and lean, as the ability to improve the operational design, identifying competitive advantages, where quality, costs, innovation, price, delivery times, delivery verification, flexibility, price reduction and waste come into play (Rojas & Gisbert, 2018). Also, it is considered a production strategy, focused on improving business productivity (Espinoza, Madrid García, & Gamboa

Gómez, 2015), likewise, it is qualified as a philosophy (Salado, Sanz, De Benito, & Galindo, 2015) as it encompasses properties, composition, causes, and effects of things, in this case, it studies everything related to the organization and its productivity, in order to develop solutions that lead a company towards continuous improvement. In other words, this methodology, based on a strategic and philosophical approach, consists of rethinking the organization, identifying errors and failures, in order to develop strategies that lead to productive efficiency, and can comply with its motto which is to do it better, in less time, and much cheaper; all this, by identifying and eliminating waste in a continuous and orderly manner.

Likewise, other authors consider it a management tool (Tejeda 2011) or organizational model (Sarria Fonseca & Bocanegra) that involves the production system, materials, people, methods and machines, which aims to improve and eliminate waste that does not add value to the processes or the final product (Tafur, 2019; León, Marulanda & González, 2016). When waste is eliminated, the quality of the product increases, as well as costs and production times decrease. This methodology, consists of being more productive, with fewer resources; such as, "time, less space, less human effort, less machinery, less materials, - as long as the customer is being given what he/she wants" (Vargas; Muratalla & Jiménez, 2016, p.6). This methodology, being considered a management tool and organizational model, is made up of principles that direct a company towards the efficient management of its production system, focused on increasing efficiency in all processes, in order to meet customer needs, and thus, the achievement of organizational goals and objectives.

Also, research topics on Lean Manufacturing, (Rodríguez, 2012; Cruz, 2016; León, Marulanda & González, 2016), explain that it is a methodology that directs towards achieving continuous improvement, since it basically seeks operational flexibility, increasing quality, effectiveness and efficiency, focused on reducing costs, increasing productivity and transmitting information and sharing it with all its human resources. Likewise, (Rojas & Soler, 2017; Vargas, Muratalla, & Jiménez, 2016; Sarria, Fonseca & Bocanegra, 2017; Kress, 2016) mention that continuous improvement, is a change that must be gestated within organizations, creating transcendental changes that lead to the optimization of the productive system, standardizing tasks and thus eliminating waste which is a fundamental point of this methodology, i.e. eliminating everything that does not add value. Another important contribution is made by Aguirre (2014), where he mentions that continuous improvement is the key to Lean Manufacturing, which depends on the co-responsibility of its workers and their ways of working. This means that the behavior, attitudes and ways of working can affect for better or worse, the achievement of the objectives set to achieve continuous improvement. For this, it is necessary to change the work methods of its collaborators, encouraging active participation, motivating them to achieve continuous improvement in all their activities and as a management task. It is essential that their managers encourage and allow the necessary changes to develop a true cultural transformation.

In view of this aspect, Piñero, Vivas & Flores (2018), mention that one of the factors that have credited success in Japanese companies, is the interrelation between "their directors, managers and workers: constancy, dedication, organization and discipline for the achievement of their goals" (p.3). This application is of utmost importance, because it is not only enough with the implementation of this methodology, but in order to achieve success and the expected results, a real work team must be formed, full of discipline and dedication, in addition to a real cultural change, where the human resource is the fundamental asset for the achievement of organizational goals.

Continuous improvement is the search for excellence in all the activities that make up the production system, where there is an order and standardization of its tasks, in order to eliminate waste that makes

the product more expensive, does not add value and does not satisfy the customer's needs. In addition, it has a cultural approach of transformation in the habits and behaviors of workers and their managers, which must be loaded with dedication, willingness and discipline to achieve a real work team, which allows the fulfillment of the objectives set by the organization. In this way, the bibliographic review on the conceptualization and objective of Lean Manufacturing, it was observed that the term waste elimination is the fundamental basis of this methodology, mentioned by forty-nine (49) of the fifty (50) files consulted. The word waste or squandering in the productive system, consists of eliminating or controlling, all those activities that do not generate value to the product and increase its costs, such as overproduction; waiting times; transportation; reprocesses, inventory; movements and defective products (Vargas; Muratalla & Jiménez, 2017, p.7; Cerón Espinoza, Madrid García & Gamboa Gómez, 2015; Monge, Reyes & Rodríguez, 2017).

Table 1. Type of Waste

Overproduction	Produce to have a stock, before it is required by the client, either because it is not going to be sold or used immediately..
Delay	Activity where the operator has to wait between one process to another, or stops due to non-existence of inputs necessary for its operation. Unnecessary stops.
Unnecessary Transportation	Movements made without any need..
Reprocesses	Repetitive activities, due to process failures, in which no customer requirement is identified.
Inventories	Inventory of products in process, finished, or Stocks of materials that are unnecessary and that do not have the immediacy for their consumption.
Unnecessary Movement	Activities carried out by operators that are not necessary in the production process.
Defective products	Manufacture of defective parts or products, which leads to the use of additional resources, in time and money, in addition to human resources for inspections.

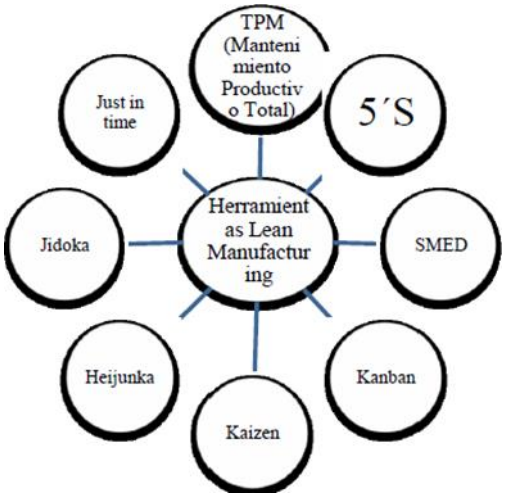
Source: Collected from the contributions given by the different authors: (Vargas; Muratalla & Jiménez, 2018, p.7; Cerón Espinoza, Madrid García and Gamboa Gómez, 2015; Monge, Reyes and Rodríguez, 2017).

Defects in the production system, generate reprocesses, cost overruns in inputs, and time spent and are a classic source of waste (Puche & Costas, 2011); (Díaz & Bermúdez, 2018). In this case, continuous improvement, proposes the execution of adjustments to achieve clean production, to make the productive system an efficient system. In this methodology, it eliminates or reduce all unnecessary operations, also generating an environment conducive to the development of activities, under a scenario of respect, motivation and worker participation. To achieve this purpose, continuous improvement is achieved through the implementation of the different tools that make up the Lean Manufacturing methodology, authors such as (Tejeda, 2011); (Añaguari, 2016) show that continuous improvement, allows, maximizing or employing only those activities that add value from the customer and product scope, this is achieved, through the application of a sum of tools known as TPM, 5S, SMED, kanban, kaizen, heijunka, jidoka, among others, developed in Japan, inspired by the principles and concepts of Deming, in addition to other authors such as "...Taiichi Ohno, Shigeo Shingo, Eijy Toyoda" (Vargas; Muratalla & Jimenez, 2016, p.7).

4.3 Tools of the "Lean Manufacturing" methodology.

The Lean Manufacturing System, as mentioned, is composed of tools that are responsible for supporting the processes, in order to establish continuous improvement and thus, the achievement of the proposed objectives. Under these precepts, it is important to review the different articles consulted, in order to demonstrate the contributions to business productivity. The tools that make up this methodology, among the most important according to the literature (Figure 1) are TPM, 5S, SMED, KANBAN, KAIZEN, HEIJUNKA, JIDOKA, JUST IN TIME.

Figure 4. Main Lean Manufacturing tools



Source: Vargas Hernández; Muratalla Bautista; Jiménez Castillo, (2016, p.8).

4.3.1 TPM

This tool is focused on total productive maintenance. It is the grouping of different maintenance actions, which allows the elimination of time loss, due to stoppages by machine failures, which hinders or hinders the productive system (Carrillo, Alvis, Mendoza & Cohen, 2019); (Figueroa, 2016); (Bravo & Hurtado, 2016); (Fernandez, 2019; Lozano & Gonzalez, 2015); (Carrillo, Giarma, Mendoza & Cohen, 2018).

- ✓ Improved control of operations.
- ✓ Increased reliability and availability of equipment.
- ✓ Reduction of monetary resources used in maintenance.
- ✓ Improved product quality.
- ✓ Reducing the financial cost of spare parts.

4.3.2 The 5S

This tool is based on five steps, in addition to the generation of a discipline and organizational culture, in relation to cleanliness, order and distribution of the elements and areas that make up a company. It is the basis for other tools to be developed. The five steps that compose it are, "Seiri: eliminate, Seiton: order, Seiso: clean, and Seiketsu: Standardize"; it is necessary, to follow the sequential order at the time of its application and implementation, in order to obtain the expected results (Jara, 2017; Pérez & Quintero, 2017); (Vargas & Castaño, 2019); (Carrillo, Alvis, Mendoza & Cohen, 2019); (Linares, 2018); (Figueroa, 2016); (Lindo, Sanz, De Benito & Galindo, 2015).

- ✓ Generates a commitment to organizational improvement for the benefit of all those who are part of it.
- ✓ Facilitates the procurement and return of elements and/or tools in the performance of the work.
- ✓ Avoids the loss of time in the search for objects necessary for the execution of the work.
- ✓ Facilitates the essential conditions to take care of work elements, such as machinery, equipment, tools, furniture, facilities, among others.
- ✓ Provides an improvement in the organization related to order and cleanliness.
- ✓ Creates the necessary conditions for the development of activities under a safe environment.

4.3.3 SMED

Generates an important contribution in productive development, since, it, reduces machinery preparation times (Vargas & Castaño, 2019); (Figueroa, 2016); (Bravo & Hurtado, 2016); (Fernández, 2019); (Ruíz, 2019).

- ✓ Reduction of machinery or equipment preparation time, bringing the productive system on time.
- ✓ Contributes to increased productive time, leading to reduced inventory.
- ✓ Reduces the dimension of the productive batches.
- ✓ Produces in the same machine, several models or production line.

4.3.4 Kanban

This tool has the meaning of visual cards, created by Toyota and used to keep track of the progress of activities in the productive system (Vargas & Castaño, 2019); (Figueroa, 2016); (Bravo & Hurtado, 2016); (Laureano & Mejía, 2019).

- ✓ Decreases or eliminates stock between interval or intermediate of processes.
- ✓ Compliance in customer deliveries.
- ✓ Improved product quality by detecting defects in a timely manner.
- ✓ Avoids inventory build-up.
- ✓ Facilitates production control.
- ✓ Facilitates production flexibility according to demand.

4.3.5 Kaizen

Kaizen consists of seeking continuous improvement of processes, where operators are allowed, to impart contributions and promote improvements, through the formation of working groups, which channel initiatives, identify problems or opportunities to implement actions to provide a solution or application (Tejeda, 2011); (Bohórquez, 2015), (Pérez & Quintero, 2017); (Vargas & Castaño, 2019); (Carrillo, Alvis, Mendoza & Cohen, 2019); (Linares, 2018); (Figueroa, 2016).

- ✓ Culture of change, to achieve sustained improvement and achieve the implementation of best practices.
- ✓ Focus on quality and excellence.
- ✓ Orientation to customer satisfaction.
- ✓ Quality control.
- ✓ Automation and system control.

4.3.6 Heijunka

Heijunka, allows the planning of demand, both in volume and variety, during a lax of time and allows giving way to continuous production flow. (Kress, 2016); (Linares, 2018); (Cardozo, Chantris; Medina and Tovar, 2019); Ruíz, 2019).

- ✓ Production adjusted to the time required.
- ✓ Leveling of the production quantity according to each reference.
- ✓ Use of automation and its human resource, called work cells.
- ✓ Continuous flow.

4.3.7 Jidoka

It is a sum of systems and devices that have the ability to detect errors in machines (Bravo & Hurtado, 2016); (Cardozo, Chantris; Medina & Tovar, 2019); (Fernández, 2019); (Benítez, 2012); (Gacharná & González, 2013); (León, Marulanda, González, 2017).

- ✓ Detects manually or automatically from the productive system, errors that are occurring in order to eliminate waste.
- ✓ Automates the productive system, taking into account the human being.
- ✓ Relates and equates people and machines or equipment in charge.
- ✓ It is in charge of controlling the process and not the product.

4.3.8 Just in Time

This just in time tool, generates a synchronization between suppliers and the productive process, for the reduction of waste in time or unnecessary stops due to the non-existence of raw material or inputs, starting from the quality, flow and intervention of the human resource (Vargas & Castaño, 2019); (Carrillo, Alvis, Mendoza & Cohen, 2019); (Linares, 2018; Bravo & Hurtado, 2016); (Cardozo, Chantris; Medina & Tovar, 2019).

- ✓ Reduced lead times, reduced inventories, improved quality.
- ✓ Facilitates operational fluidity and timely feedback.
- ✓ Satisfies customer needs, by delivering the desired product, quantity, conditions and characteristics agreed and desired.

The tools described above, generate in the production system, the continuous improvement of processes, quality, elimination of waste, organization, cleanliness, and a better working environment, the latter being of utmost importance, so that the other activities of the organization and therefore the production system are carried out efficiently and effectively. Additionally, they bet on the reduction or elimination of unnecessary time used in the development of activities that do not add value to the product, all of which will be reflected in increased productivity and cost reduction. In this sense, any organization that uses these tools will be more competitive, will offer quality products, and will stand out for satisfying customer needs.

4.4 Cases of Lean Manufacturing application in the industry.

4.4.1 Main tools applied.

As mentioned in the previous paragraphs, the Lean Manufacturing methodology is composed of a series

of tools focused on directing a company towards the continuous improvement of its processes. Lean Manufacturing demands a transcendental change in the organizational culture, which requires the adaptation of different techniques that seek to improve the production systems; however, its application varies according to the interests and purposes of each company.

Table 2 shows the most commonly used tools in studies carried out in sectors of the economy and specific cases of manufacturing companies, where the following could be established:

Table 2. Most used tools in the industry.

Tool	#Company	Relative frequency (%)
5S	16	21,33%
Kaizen	13	17,33%
Kanban	11	14,67%
SMED	11	14,67%
TPM	9	12,00%
TAK TIME	3	4,00%
VSN	2	2,67%
Heijunca	2	2,67%
Poka Yoka	2	2,67%
Jidokas	2	2,67%
Seix sigma	1	1,33%
Visual control	1	1,33%
KPIS	1	1,33%
Manufacturing	1	1,33%
Total	**75**	**1**

Source: Own authorship.

Among the most applied techniques are the 5s (21.23%), focused on process improvement, organization and discipline. The problems most identified in this review are the amount of waste, due to the lack of application of Lean Manufacturing techniques. The companies, where this tool was applied, developed the five steps, resulting in higher productivity, elimination of elements and waste, achieving greater organization, cleanliness and better distribution of work areas, generating a positive impact on productivity and thus, increasing profitability and value generation of each of these companies (Quintana, 2010); This shows that this methodology generates great results, and should be applied in all manufacturing companies, as it allows the development of strategies that lead to continuous improvement, which is the fundamental basis of Lean Manufacturing.

Following the application of the 5s, another technique used is the Kaizen tool (17. 33%), allowed the optimization of the production system, where more is produced in less time and with fewer inputs, notoriously reducing reprocesses and returns especially in a company that presented 73% of these, due to failures in the processes and quality control (Orozco, Cuervo and Bolaños, 2016);The application of this tool allowed a uniformity of processes, reduction of errors and human failures, creating work teams focused on quality and continuous improvement. In addition, it was observed that the development of this technique eliminates tasks that do not generate value in the production system, such as unnecessary

displacements. All this resulted in these companies, effective processes, product quality, delivery fulfillment and customer satisfaction.

The Kanban tool (14.67%) is also another protagonist in the cases developed by these companies, focused on achieving efficient processes, where standardization allows an alignment of processes, without the existence of a variation that has not been previously established.The variations in the processes do not allow the detection of failures, and thus generate waste, so the control established by this tool allows determining situations of improvement and timely action, to avoid unnecessary stoppages and waste that increase production costs.

The SMED tool (14.67%), used in these companies, facilitated the achievement of savings in production time, in relation to machine changes and number of references developed, which generates the elimination and control of costs, increasing efficiency in the production system. This tool is essential for those companies that manufacture different products, allowing them to work in batches and where the changeover from one to another is done in the shortest possible time, avoiding unnecessary stops.

On the other hand, among the less used tools are TPM, Tack Time, Heijunka Jidoka, VSN, POKA YOKE, Visual Control and Cellular Manufacturing.that its application does not make an important contribution, since in the case of the companies that applied it, they obtained positive results obtained positive results that are an example that all Lean Manufacturing tools contribute efficiency and effectiveness to productive development (Buitrón, 2019); However, we can see the case study in the bakery sector (Figueroa, 2016), where there are serious deficiencies in the productive system, including process variability, disorders and waste in inputs and where they recognize that, although they have developed Lean Manufacturing tools, they have not managed to eliminate failures and waste. Most managers in this sector say that this tool has not been adequately developed and that standardization has not been carried out correctly. They attribute many of its failures to the lack of discipline and commitment of management and personnel. In view of this, it can be said that the development and application of Lean Manufacturing, generates important contributions to a company, as long as there is commitment from management and workers to make a cultural change, in addition to this, the success depends on whether this methodology was implemented correctly, in addition, if there are controls that allow decision making, for the implementation of improvement actions and thus establish continuous improvement.

4.4.2 Results of the implementation of lean manufacturing tools

The results evidenced after the application of the above tools can be seen in Table 3, where the main results of studies applied to sectors of the economy and to specific companies in the manufacturing sector are listed:

Table 3. Results of Lean Manufacturing tools in the industry.

Lean Manufacturing Application Results		Autor	Percentage of studies %	
Org	Cleanliness and organization	Ruiz (2016); (Fernández, 2019); (Ari & León, 2019); Chirinos, (2020)	4,1	
	Improved plant layout	Linares (2018); Díaz & Bermúdez, (2018); Quintana, (2010),Torrente, Rodríguez Santana & Murcia (2019);	4,1	
	Safety and hygiene in the execution of work.	Lozano y González (2015).	1,0	

	Improvement of corporate image	Fernández, (2019); Quintana, (2010); Lozano y González(2015).	3,1	20,6
	Culture of change	Ruiz (2019); Silva, (2013); Gorka, (2019); Bellido, La Rosa,Torres, Quispe & Raymundo, (2018); Valderrama & Pampa(2018)	5,2	
	Synergy and teamwork	Orozco, Cuervo y Bolaños, (2016); Fernández, (2019);Lozano y González (2015)	3,1	
Rendimientos de la Productividad	Control and monitoring of activities	Benítez (2012); Cardozo, Chantris, Medina & Tovar, (2019);(Ramírez, 2017)	3,1	29,9
	Process standardization	Díaz & Bermúdez (2018); Medina & Rodríguez (2021)	2,1	
	Efficiency and production optimization	Orozco, Cuervo y Bolaños, (2016); Ramírez. (2017); Quintana, (2010) Gorka, (2019); Cardona,(2013); Cardozo,Chantris Medina &Tovar (2019); Ruiz, (2016); Aranibar (2016); Díaz & Bermúdez (2018); Linares (2018); Buitrón, (2019); Gacharná & González (2013); Benítez (2012); Medina & Rodríguez (2021); Torrente, Rodríguez Santana & Murcia (2019)	14,4	
	Quality products	Malpartida, (2020); Ruiz (2016); Quintana, (2010): Aranibar(2016); Gacharná & González (2013); Lozano y González (2015)	6,2	
	Continuous improvement.	Cardona, (2013); Cardozo, Chantris Medina &Tovar (2019);Ramírez (2017); Buitrón, (2019);	4,1	
Error reduction	Elimination of unnecessary positions	Torrente, Rodríguez Santana & Murcia (2019), Linares(2018), Cardozo, Chantris Medina &Tovar (2019)	3,1	49.5
	Reduction of unnecessary movements and displacements.	Orozco, Cuervo y Bolaños, (2016); Linares (2018); Bellido,La Rosa, Torres, Quispe & Raymundo, (2018); Aranibar (2016); Cardozo, Chantris Medina &Tovar (2019); Ramírez(2017)	5,2	
	Reduction in machine setup hours	Salazar (2019); Torrente, Rodríguez Santana & Murcia(2019); Linares (2018), Díaz & Bermúdez (2018); Ruiz, (2019); Cardozo, Chantris, Medina & Tovar, (2019)	6,2	
	Elimination of unproductive hours	Orozco, Cuervo y Bolaños, (2016); Malpartida, (2020); Silva, (2013); Salazar (2019); Cardona, (2013); Gorka, (2019); Linares (2018); Cardozo, Chantris Medina &Tovar (2019); Díaz & Bermúdez (2018); Valderrama & Pampa, (2018); Chirinos, (2020)	11,3	
	Minimization of inventory, inputs, work-in-process and finished products.	Malpartida, (2020); Silva, (2013); Ramírez (2017); Ari & León, (2019); Bellido, La Rosa, Torres, Quispe & Raymundo, (2018); Cardozo, Chantris Medina &Tovar (2019); Aranibar (2016); Medina y Rodríguez, (2021)	8,2	
	Identification of faults or errors in processes	Malpartida, (2020); Benítez (2012); Quintana, (2010); Gacharná & González (2013); Linares (2018); Cardozo,Chantris Medina &Tovar (2019); Ramírez (2017); Medina &Rodríguez (2021); Torrente, Rodríguez Santana & Murcia (2019); Linares (2018); Ramírez (2017); Ruiz, (2016)	12,4	
	Cost reduction	Lozano y González (2015); Ramírez (2017); (Valderrama &Pampa, 2018)	3,1	

Source: Own Authorship, based on the contributions given by the cited authors.

5. Discussion

The table above shows the results found in the different publications where the Lean Manufacturing methodology has been implemented, finding in general positive results, which were grouped under three (3) factors: Organizational (20.6%), productivity (29.9) and waste reduction (49.5%). The elimination of waste represents the most outstanding results. Among the contributions that stand out most in the organizational area are culture of change (5.2%); better distribution in the plant (4.1) and cleanliness and organization (4.1). In the productive area, efficiency and productive optimization (14.4%); and in the reduction of waste, identification of faults and errors in processes (12.4%), elimination of

unproductive hours (11.3%); in addition, minimization of inventory, inputs, products in process and finished product; reduction of machine preparation hours; reduction of movements and displacements; elimination of unnecessary positions and reduction of costs.

The application cases consulted in this research show significant experiences. These benefits are of utmost importance for any company that wishes to improve its competitiveness, since having an optimal productive development, focused on the customer, on the quality of the products, on the continuous improvement, will allow greater profitability and sustainability, since the idea of any business is to project itself in the long term, to have the conditions to face the fluctuating changes of the economy, to generate value to its internal and external customers, since the business success lies in the latter two. Internal customers, through their motivation and efficiency, make possible the development of business activities and external customers, through the demand for their products generate sustainability, as long as these satisfy their needs.

6. Conclusions

In the review of the articles, it was observed that most of the authors determine this methodology as a philosophy, strategy or management model, in charge of minimizing waste, improving quality, reducing time, continuous improvement and better use of production costs. Lean Manufacturing has its origins in Toyota, who designed the lean production model, which also means lean production, which translates as agile and flexible. It is focused on doing more with fewer resources, such as time, movements, raw materials, inventories, taking advantage of all available resources, allowing effectiveness and eliminating everything that does not generate value in the production system. The development of this methodology is integrated by a series of tools, in charge of the improvement of processes, cultural changes and customer satisfaction, where its application configures transcendental changes for the company.

Lean Manufacturing is a methodology focused on the continuous improvement of production systems, eliminating the neuralgic points of the system where waste is found. It is an integrating system of principles and tools that allows companies that implement it to reduce costs and increase productivity. The most used tools in the object of application of several of the consulted authors are 5 S, Kaizen, Kanban and SMED, because reprocesses, dead times, unnecessary displacements and wastes are the most common difficulties in most organizations, causing problems in their productive systems, factors that are eliminated or corrected through these tools.

Companies seek to eliminate all those activities that do not add value to their processes, eliminating waste, which is characterized by overproduction, waiting, unnecessary transportation, reprocesses, inventories, unnecessary movements and defective products. Therefore, they apply tools such as the 5'S, which can solve problems of "cost overruns, unproductivity, reprocesses and waste, consequences of the lack of organization, control in processes and raw materials" (Vargas; Muratalla & Jiménez, 2018, p.7).

The 5'S tool, as it could be observed in the analyzed works, managed to improve productivity, generating positive aspects not only in the productive system, but the way of performing the work of its collaborators. On the other hand, the Kaizen methodology allows the increase of products, providing quality in the development of its processes and finished products, therefore, the elimination of waste, such as unnecessary stops, movements and lack of methodologies in the development of processes, is achieved as a result that companies implement continuous improvement, in order to achieve productive efficiency. In relation to the Kanban tool, it is the one that allows the standardization of processes, with which, companies achieve productive efficiency, because there is a control in the development of their

processes, in order to make them more uniform. The SMED tool allowed time savings in the production system, in relation to machine changes given the number of references developed, eliminating delays, unnecessary stops and cost overruns, increasing efficiency in the production system.

Once the results of this bibliographic research were analyzed, it could be observed that the Lean Manufacturing methodology is important to achieve efficiency and productive effectiveness, giving solution to the waste found in the companies, generating a control and organization of the processes, transforming a culture focused on customer satisfaction and on the human resource as a key factor of success of any company, since they are the ones who develop each of the tasks that integrate an organization and achieve continuous improvement. The research was also able to establish that, in order to achieve success in the development of this methodology, there must be the full commitment of the management and its directives, so that, through their leadership, they can influence their human resources, to direct the continuous improvement and the cultural changes that this methodology entails.

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Makalenin Türkçe başlığı buraya yazılır….

Özet

Türkçe özet.

Anahtar sözcükler: anahtar sözcükler1; anahtar sözcükler2; anahtar sözcükler3

AUTHOR BIODATA

Insert here author biodata**.**