Implementation selected tools of Lean Manufacturing

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CHAPTER 1: INTRODUCTION
1.1. Aim and scope of the project

The aim of the project is the implementation of manufacturing tools to improve the quality and the productivity of a Company. The purpose of this project is to carry out a study of the current situation of a company and try to make improvements based on Lean Manufacturing. The main purpose of the project is define, develop and implement production improvements to increase productivity, flexibilizing, reduce waste, reduce inventory, reduce space, delete safety stocks... In short, implement improvements productivity to make this as efficient as possible.

In order to implement these tools to improve the production is essential to define the concept of productivity. Subsequently proceed to undertake a study of enhancement tools that will be implemented as well as a brief description and the method of application of each. Finally there will be a description of the company where this tools are going to be held and which implements are necessary to improve the production of this Company.

1.2. Substantiation of the project

Due to the historical moment in which we find ourselves and the world economic crisis in which we are involved, one way to deal with this is the application of these techniques in the production process. The application of Lean manufacturing is not a charge too high but still may be able to get amazing improvements economically. In today's accelerating, expanding and frequently volatile markets, demand can be exceedingly difficult to predict. As orders are processed through digital channels, demand changes moment by moment. In order to respond to such change—and keep the costs of responding at minimum levels—companies must have the capabilities to meet demand as it occurs.
CHAPTER 2: LEAN MANUFACTURING

Lean Manufacturing can be defined as an approach to the identification and elimination of waste (non-value added activities) through continuous improvement by flowing the product in a way to "pull" from the customer in pursuit of perfection.

This methodology of improving manufacturing efficiency was conceived in Japan by Taiichi Ohno. In 1937, Ohno noted that before the war, Japanese productivity was much lower than the U.S.. After the war, Ohno visited the United States, where he studied the major pioneers of productivity and waste reduction in the country as Frederick Taylor and Henry Ford. Ohno was impressed by the overemphasis that Americans put into mass production of large volumes to the detriment of the variety, and the level of waste generating industries that the richest country in the war. When he visited the supermarket had an inspiring effect immediately; Ohno found in them a perfect example of his idea of managing reduced inventories, eliminate unnecessary steps and monitor activities and provide primary control that does the work (in this case the client) as support to the value chain. The Japanese word dumb means 'waste' and refers specifically to any human activity that consumes resources and creates no value.

The goal is to find tools that help eliminate all waste and all operations that do not add value to the product or process, increasing the value of each action and eliminating what is not required. This manufacturing process is related to the use of activity-based costing (generation of activity-based costs') which, according to its original-looking costs relate to all the values that the customer receives the product. On the other hand, serves to establish a philosophy of continuous improvement that allows companies to reduce their costs, improve processes and eliminate waste to increase customer satisfaction and maintain profit margins. The goal of lean manufacturing is to be useful to the community, which means being in search of continuous improvement.

The principles keys of lean manufacturing are:

- Perfect quality to the first: quest for zero defects, detection and resolution of problems at their source.

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1 Taiichi Ohno (1912-1990) was the engineer who designed the Toyota production system just in time (JIT) within the car manufacturer.
2 Frederick Taylor (1856 - 1915) was a mechanical engineer and economist, who was the promoter of scientific management. In 1903 he published his book called Shop Management where he introduces the concepts of creating a mental revolution and a functional worker.
3 Henry Ford (1863 -1947) was the founder of the Ford Motor Company and father of modern production lines used in mass production.
- Minimizing waste: elimination of all activities that are not value-added networks and security, optimizing the use of scarce resources (capital, people and space).
- Continuous improvement: reducing costs, improving quality, increasing productivity and information sharing.
- Processes "pull" products are pulled (in the sense requested) by the client end, not pushed by the end of production.
- Flexibility: different mixes quickly produce a variety of products, without sacrificing efficiency due to lower production volumes.
- Building and maintaining a long term relationship with suppliers taking risk-sharing agreements, and information costs.

Lean is basically everything about getting the right things in the right place, at the right time, in the right amount, minimizing waste, being flexible and open to change.

One of the philosophies of Lean Manufacturing is continuous improvement (Kaizen). Assuming that the time is the best single indicator of competitiveness, acts to be able to recognize and eliminate waste in the company, either in existing production processes or in the planning stage of new products, maintenance of machines or including administrative procedures. The statement that best defines this philosophy is:

"Today better than yesterday, tomorrow better than today!"\(^4\)

and its meaning is that you can always do better. In Japanese culture is introduced the concept that no day should pass without some improvement.
2.2. Characteristics of tools of Lean Management

This chapter will present the different techniques currently known for improving production.

2.2.1. Empowerment

The management concept of employee empowerment can be defined as the creation of an environment in which people at all levels feel they have real influence over standards of quality, service, and business effectiveness within their areas of responsibility. It is a strategy and philosophy that enables employees to make decisions about their jobs. In an organization where this style of management is not natural, adopting a management style that embraces empowerment will be a difficult but critical change in order to succeed in the effort of implementing Lean Enterprise Thinking.

As Andre Larabie, Ph.D. says in his article *Empowerment in the Workplace*:

Empowerment can be defined as follows:

To give power to; to enable or permit; to give authority to or authorize.

Nevertheless, empowering the workforce doesn't mean that management gives up control and lets people do whatever they please. Instead, guidelines and boundaries need to be set so that everyone knows the limits of how they can operate. A process needs to be established that allows management to set the direction for the organization but lets the workforce find unique ways to achieve these goals and objectives. By letting the workforce be free to implement ideas within their work areas, management will find that the organization is much more productive than by following the direction of a few select individuals. The trick is to leverage one's self though the talents of everyone involved.

The process of adapting an empowerment style of operating within the organization is not solely the responsibility of management. True, a manager needs to learn to let go without giving up total control, but in order for empowerment to work, the employee must accept it and the responsibility that goes with it. In short - they have to take it. However, not all are willing or able to do, or they do not know how and what it means, so care must be taken to educate and transition those involved.

When an organization implements empowerment, manages to increase its internal competitiveness in an exponentially way, as the empowerment keys are:

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5 Article Source: http://EzineArticles.com/6541445
• Promotes teamwork.
• Release all the existing experience and knowledge of personal.
• Facilitates the development and implementation of standards to guarantee the necessary quality requirements customers, both external and internal.
• Increases levels of involvement and motivation of the entire template.
• Accelerate the processes of learning and innovation, since they are based on fault tolerance and trust another.
• Extends the correct delegation.
• Generally involves the implementation of a system management by objectives, which favors monitoring of progress.

2.2.2. The 5's

5S methodology is considered one of the basic principles of the Lean to maximize efficiency in the workplace, and to have the possibility of product diversification, higher quality, lower costs, reliable deliveries, etc.

The implementation of 5S allows the formation of habits of cleanliness and order between operators, technical, administrative and managerial. By using the technique of 5S in the business, we are referring to the implementation of the same to maintain jobs and other areas of a company clean, orderly and only the necessary.

The 5 S's are the foundation of industrial productivity model created in Japanese and Western companies applied today. The 5S philosophy is not a current improvement of work but a philosophy applies to all levels in our everyday life in today's society.

5 S's is a philosophy of work that allows you to develop a systematic plan to continuously maintain the classification, order and cleanliness, allowing immediately increased productivity, enhance security, climate labor, staff motivation, quality, efficiency and, consequently, the competitiveness of the organization. This methodology was developed by Hiroyuki Hirano, and is called 5S because the initials of the Japanese words Seiri, Seiton, Seiso, Shitsuke Seiketsu meaning classification, order, cleanliness, standardization and discipline. The 5S are divided into two major parts.

http://www.elprisma.com/apuntes/ingenieria_industrial/5slascincos/
The first 3 S are oriented things as working conditions and overall working environment.

- Classification - Involves removing the workspace those objects and tools are not necessary to perform the tasks daily, leaving only those that are required to work in a production and quality. By the classification must be removed waste, optimizing the working and storage areas and generally increases productivity.

- Order - Organization of the elements that we have classified as necessary so that they can be found easily by anyone in the work environment. Sort has to do with improving the visualization elements in the environment. This reduces the time engaged in the search of materials, supplies or tools, are has areas cleaner and promotes a culture of order.

- Cleaning - Keep the work area clean to create an environment suitable for daily production with good quality and pleasant atmosphere. Cleaning means removing dirt and dust from all the elements Company. It is also convenient sources dirt inspect the machine during the cleaning process in order to identify leakage problems, malfunctions or defects.

The 4th and 5th S are oriented to oneself as a person

- Standardization. - Everything about the state of health both physically and mind that requires a person to be in optimum condition to perform their daily work with quality. It aims to maintain the state of cleaning and organization achieved with the application of the first 3 S. Suggests seen as grooming habits, medical review, adequate rest, positive attitude at work, compliance and security final quality that brings any value to the worker. To achieve needed to create objective standards for cleaning and inspection actions of periodic and permanent self.

- Discipline - The effect of the first four S's will disappear if there is no the discipline necessary to help incorporate them into daily habits, this means avoid removing the existing procedures. It consists basically enhance monitoring through discipline standards formalized giving importance to the benefits related to the implementation the first four S's.
2.2.2.1. Seiri (Classification)

The real purpose of this first S is to eliminate the unnecessary. Sort means to separate the necessary from the unnecessary things, and then remove from the site all objects that do not require so keep only the essentials for work. For proper implementation of the same has been demanding decisions to while careful to classify the different elements. We identified three groups to sort items:

- Necessary or Forced constant use.
- Needed for occasional use.
- Unnecessary.

To make the physical classification of the elements and to assess the importance of all items that are in the work area, initial classification was made based strictly on the necessity thereof. The strategy to be followed for the classification is found in the following diagram.

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Fig 3. SEIRI Unwrap and remove unnecessary
2.2.2.2. Seiton (Order)

It is at this stage where once selected the necessary elements to be identify them and their location. It is necessary also identify plant area belongs. The objective of this tool is that any element has a location so the item are quickly recognized by any person belonging to the working environment and on the other hand minimizing search times of the elements of the work area\(^8\). The methodology used to define these concepts is exposed in the diagram below which will be used to apply the tool.

Fig 4. SEITON Order

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\(^8\) http://world-class-manufacturing.com/es/5S/Seiton.html
2.2.2.3. Seiso (Cleanliness)

Implementing Seiso includes finding the keys to achieving and maintain cleanliness in the work area. To reach the goal requires meet some basic rules defined below:

1. No mess. Reduce or eliminate factors that could cause contamination. At any time, remove immediately any situation of dirt that has been generated.

2. Remove dirt, defects or imperfections, leaving the media work (machines, equipment, facilities, tools, furniture, etc.) clean (no grease, dust, etc.)
   - Working in a cluttered environment is dirty and unsafe with high risk of accidents and also directly affect the quality matched manufactured products.
   - The key to success in achieving and maintaining cleanliness of a company depends on the attitude of staff and participation form.

3. Procedures to conduct a cleaning operation:
   - Design a program for cleaning (daily newspaper) with tasks clearly defined (who, when, how, where)
   - Periodically check that those responsible for implementing maintain the level tasks accomplished.
   - Designate who is responsible for maintenance team clean and secure by checking her figure tasks performed.
   - Clearly define the boundary lines of areas and responsibility to ensure that no dead areas (no charge). These areas are usually covered areas or passing by its location are not clearly defined.
   - Ideally, responsible for cleaning up an area to assess another area outside his execution.
   - Difficult or hidden areas require a special assessment and if the results were not the desired one that demonstrates specific patrol intention to achieve the highest levels of safety, quality and Productivity.
2.2.2.4. Seiketsu (Standardize)

The objective is to develop clear rules to ensure the maintenance of the results obtained implement the S’s previous. As in Seiso there are a number of standards note:

1. To maintain and continuously improve procedures and standards used in implementing 5S Plan is necessary to collect written those elements that have facilitated progress in the first three S's. By therefore it is recording all actions that have been carried out with the result.

2. Depending on the areas (manufacturing, administrative, etc.) will develop a 5S implementation manual. This manual should contain at least:

- Initial conditions prior corresponding workspace (Area occupied in plan distribution)
- General Layout areas, furniture and equipment that form (Include area and is responsible for the contact).
- The plan standardizes documentation must be available to Plant anyone. Progress must be visible through informative illustrations and information of the panels has to be updated periodically.
- After obtaining the desired results define and procedures for cleaning. These procedures will be reviewed periodically.

Management must design systems and procedures to ensure continuity of seiri, seiton and seiso, which is the other meaning of seiketsu (systematic).9

2.2.2.5. Shitsuke (Discipline)

This S is the most weight in the implementation and consolidation of results since without it the goals achieved with the implementation of the rest of S's was dissipate over time. Shitsuke therefore has to ensure the creation and maintaining good safety and efficiency in the field of housekeeping items, people and places of employment. In summary has to be the philosophy that prevails within the company. Because habits generated by the practice of these activities are to be derive advantages:

- Greater freedom of personal performance in the workplace without rigorous oversight.

9 [http://www.tuobra.unam.mx/publicadas/040119152742-6_.html](http://www.tuobra.unam.mx/publicadas/040119152742-6_.html)
- Less stress on repetitive practice of program activities.
- Increased efficiency and job satisfaction.
- More careful management and conservation of the features individual and collective production.

To achieve higher levels required by competition Company staff discipline and commitment using standards established and cooperating on practical application and improvement of procedures.

2.2.3. Poka Yoke

A poka-yoke is a device designed carefully to avoid errors in the operation of a system. Some authors handle the poka-yoke as an anti-stupid, which guarantees the safety of machinery and processes to users. Thus, they prevent any accidents. These devices were introduced at Toyota in the 1960s, by engineer Shigeo Shingo\textsuperscript{10} within what is known as the Toyota Production System. Although prior poka-yokes existed, it was not until his introduction when Toyota became a technique, common today, quality. The table below demonstrate the different errors that can occur during a process, this information is taken from the book Human Errors\textsuperscript{11}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Fig5.png}
\caption{Typical errors}
\end{figure}

\textsuperscript{10} Shigeo Shingo (1909-1990) Japanese industrial engineer who was hired in 1955 as a consultant at Toyota Motor Company
\textsuperscript{11} James Reason, 1990 Cambridge Univ. Press
Moreover, Shingo stated, in his book\textsuperscript{12}, that the cause of the error was in labor of the workers and defects in manufactured parts were produced by themselves. Consequently fit two possibilities or objectives to achieve with poka-yoke:

- Somehow preclude human error, putting obstacles to disallow these errors, such as making some cables for recharging mobile phone batteries and DC devices which can only be connected with the correct polarity, it is impossible to reverse, since the connector pins are of different size or shape.

- Highlight the error that is so obvious to him that he has committed. Shingo cites the following example: a worker has to assemble two buttons on a device by placing them under a pier, to prevent the failure of the latter on one of the buttons the worker must take before assembly, two pier from the box where all stored and would deposit on a tray or dish, once completing the assembly, the worker could tell immediately of forgetfulness with a glance at the tray, something impossible to do by looking at the box piled high with lots of springs.

Currently the poka-yokes usually consist of:

- Detection system, which depends on the feature type to control and in terms of which are usually classified
- Alarm system (visual and audible commonly) that alerts the worker of the error to remedy the same.

<table>
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<tr>
<th>Techniques Poka Yoke-Safe</th>
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<tr>
<td><strong>When we find errors?</strong></td>
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<tr>
<td><strong>Before they occur:</strong> Prediction and Prevention</td>
</tr>
<tr>
<td><strong>After they occur:</strong> Detection</td>
</tr>
<tr>
<td><strong>Termination or suspension of activities</strong></td>
</tr>
<tr>
<td>Prediction</td>
</tr>
<tr>
<td>When an error is about to happen</td>
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<tr>
<td><strong>Control</strong></td>
</tr>
<tr>
<td>The errors are impossible</td>
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<tr>
<td><strong>Warning</strong></td>
</tr>
<tr>
<td>When something is about to fail</td>
</tr>
</tbody>
</table>

Tab 1. Comparation between different errors

\textsuperscript{12} Zero Quality Control: Source Inspection and the Poka-Yoke System by Shigeo Shingo (Apr 1, 1986)
The best way to develop the Poka Yoke process is to follow the methodology set out below.

**Development of Poka Yoke**

- Make a manufacturing process
- Identify all potential errors
- Identify design features that can eliminate the error
- Redesigned to eliminate the possibility of error
- Redesigned to make it obvious that an error will happen
- Redesign for obvious error occurred
- Review the design to detect potential errors in Manufacturing and Assembly

Fig 7. Development of Poka Yoke
2.2.4. Value Stream Mapping

The Value stream mapping or mapping the value chain is a visual tool that allows Lean Manufacturing to identify all activities in the planning and production of a product, in order to find opportunities for improvement that have an impact on the entire chain and not in separate processes.

This tool is based on the layout of two maps of the value chain, one present and one future, that will make it possible to document and display the current status and actual process to be improved, and the subsequent state, ideal or that want to achieve once they have made improvement activities.

The VSM is a graph consisting of icons and symbols that describe simple and mainly two types of flow: The flow of information (planning), which covers the activities from which the customer makes the order until a work order or production is generated. The other is the flow of materials (manufacturing), which takes into account all the processes needed to produce the good, until it is delivered to the customer.

Each of the operations or processes assigned performance indicators or measures that reveal and display the current status of the process and usually include cycle time, setup time and baseline shift, number of players per team, percentage rejections, equipment availability, downtime, efficiency, among others.

Once indicators have been allocated and drawn to the VSM (Value Stream Map), identify improvement opportunities and prioritized according to the impact they have on reducing cost, increasing flexibility and improving productivity and quality. Finally we draw the future map which will help us visualize the state of the process after the execution of the opportunities found.

Below it is show the icons and the definition of each.

<table>
<thead>
<tr>
<th>Icon</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td><img src="image" alt="Customer/Supplier Icon" /></td>
<td>Customer/Supplier Icon: represents the Supplier when in the upper left, customer when in the upper right, the usual endpoint for material.</td>
</tr>
<tr>
<td><img src="image" alt="Dedicated Process Icon" /></td>
<td>Dedicated Process flow Icon: a process, operation, machine or department, through which material flows. It represents one department with a continuous, internal fixed flow.</td>
</tr>
<tr>
<td><img src="image" alt="Shared Process Icon" /></td>
<td>Shared Process Icon: a process, operation, department or workcenter that other value stream families share.</td>
</tr>
<tr>
<td><img src="image" alt="Data Box Icon" /></td>
<td>Data Box Icon: it goes under other icons that have significant information/data required for analyzing and observing the system.</td>
</tr>
<tr>
<td><img src="image" alt="Workcell Icon" /></td>
<td>Workcell Icon: indicates that multiple processes are integrated in a manufacturing workcell.</td>
</tr>
<tr>
<td>Icon</td>
<td>Description</td>
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<tr>
<td>------</td>
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</tr>
<tr>
<td><img src="image" alt="Inventory Icon" /></td>
<td>Inventory Icons: show inventory between two processes</td>
</tr>
<tr>
<td><img src="image" alt="Shipments Icon" /></td>
<td>Shipments Icon: represents movement of raw materials from suppliers to the Receiving dock/s of the factory. Or, the movement of finished goods from the Shipping dock/s of the factory to the customers</td>
</tr>
<tr>
<td><img src="image" alt="Push Arrow Icon" /></td>
<td>Push Arrow Icon: represents the “pushing” of material from one process to the next process.</td>
</tr>
<tr>
<td><img src="image" alt="Supermarket Icon" /></td>
<td>Supermarket Icon: an inventory “supermarket” (kanban stockpoint).</td>
</tr>
<tr>
<td><img src="image" alt="Material Pull Icon" /></td>
<td>Material Pull Icon: supermarkets connect to downstream processes with this &quot;Pull&quot; icon that indicates physical removal.</td>
</tr>
<tr>
<td><img src="image" alt="FIFO Lane Icon" /></td>
<td>FIFO Lane Icon: First-In-First-Out inventory. Use this icon when processes are connected with a FIFO system that limits input.</td>
</tr>
<tr>
<td><img src="image" alt="Safety Stock Icon" /></td>
<td>Safety Stock Icon: represents an inventory “hedge” (or safety stock) against problems such as downtime, to protect the system against sudden fluctuations in customer orders or system failures.</td>
</tr>
<tr>
<td><img src="image" alt="External Shipment Icon" /></td>
<td>External Shipment Icon: shipments from suppliers or to customers using external transport</td>
</tr>
<tr>
<td><img src="image" alt="Kaizen Burst Icon" /></td>
<td>Kaizen Burst Icon: used to highlight improvement needs and plan kaizen workshops at specific processes that are critical to achieving the Future State Map of the value stream.</td>
</tr>
<tr>
<td><img src="image" alt="Operator Icon" /></td>
<td>Operator Icon: represents an operator. It shows the number of operators required to process the VSM family at a particular workstation.</td>
</tr>
<tr>
<td><img src="image" alt="Other Icon" /></td>
<td>Other Icon: other useful or potentially useful information.</td>
</tr>
<tr>
<td><img src="image" alt="Timeline Icon" /></td>
<td>Timeline Icon: shows value added times (Cycle Times) and non-value added (wait) times. Use this to calculate Lead Time and Total Cycle Time.</td>
</tr>
<tr>
<td><img src="image" alt="Go See Icon" /></td>
<td>Go See Icon: gathering of information through visual means.</td>
</tr>
<tr>
<td><img src="image" alt="Verbal Information Icon" /></td>
<td>Verbal Information Icon: represents verbal or personal information flow.</td>
</tr>
<tr>
<td>Icon</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td><img src="image" alt="Production Control Icon" /></td>
<td>Production Control Icon: This box represents a central production scheduling or control department, person or operation.</td>
</tr>
<tr>
<td><img src="image" alt="Manual Info Icon" /></td>
<td>Manual Info Icon: A straight, thin arrow shows general flow of information from memos, reports, or conversation. Frequency and other notes may be relevant.</td>
</tr>
<tr>
<td><img src="image" alt="Electronic Info Icon" /></td>
<td>Electronic Info Icon: This wiggle arrow represents electronic flow such as electronic data interchange (EDI), the Internet, Intranets, LANs (local area network), WANs (wide area network). You may indicate the frequency of information/data interchange, the type of media used ex. fax, phone, etc. and the type of data exchanged.</td>
</tr>
<tr>
<td><img src="image" alt="Production Kanban Icon" /></td>
<td>Production Kanban Icon: This icon triggers production of a pre-defined number of parts. It signals a supplying process to provide parts to a downstream process.</td>
</tr>
<tr>
<td><img src="image" alt="Withdrawal Kanban Icon" /></td>
<td>Withdrawal Kanban Icon: This icon represents a card or device that instructs a material handler to transfer parts from a supermarket to the receiving process. The material handler (or operator) goes to the supermarket and withdraws the necessary items.</td>
</tr>
<tr>
<td><img src="image" alt="Signal Kanban Icon" /></td>
<td>Signal Kanban Icon: used whenever the on-hand inventory levels in the supermarket between two processes drops to a trigger or minimum point. It is also referred as “one-per-batch” kanban.</td>
</tr>
<tr>
<td><img src="image" alt="Kanban Post Icon" /></td>
<td>Kanban Post Icon: a location where kanban signals reside for pickup. Often used with two-card systems to exchange withdrawal and production kanban.</td>
</tr>
<tr>
<td><img src="image" alt="Sequenced Pull Icon" /></td>
<td>Sequenced Pull Icon: represents a pull system that gives instruction to subassembly processes to produce a predetermined type and quantity of product, typically one unit, without using a supermarket.</td>
</tr>
<tr>
<td><img src="image" alt="Load Leveling Icon" /></td>
<td>Load Leveling Icon: a tool to batch kanbans in order to level the production volume and mix over a period of time.</td>
</tr>
<tr>
<td><img src="image" alt="MRP/ERP Icon" /></td>
<td>MRP/ERP Icon: scheduling using MRP/ERP or other centralized systems.</td>
</tr>
</tbody>
</table>

Fig 8. Icons of Value Stream Mapping
2.2.5. Total Productive Maintenance (TPM)

TPM\textsuperscript{13} is an innovative Japanese concept. The origin of TPM can be traced back to 1951 when preventive maintenance was introduced in Japan. However the concept of preventive maintenance was taken from USA. Nippondenso was the first company to introduce plant wide preventive maintenance in 1960. Preventive maintenance is the concept wherein, operators produced goods using machines and the maintenance group was dedicated with work of maintaining those machines, however with the automation of Nippondenso, maintenance became a problem as more maintenance personnel were required. So the management decided that the routine maintenance of equipment would be carried out by the operators, so maintenance group took up only essential maintenance works. The aim of productive maintenance was to maximize plant and equipment effectiveness to achieve optimum life cycle cost of production equipment.

TPM was introduced to achieve the following objectives. The important ones are listed below.

- Avoid wastage in a quickly changing economic environment.
- Producing goods without reducing product quality.
- Reduce cost.
- Produce a low batch quantity at the earliest possible time.
- Goods send to the customers must be non defective

The TPM program closely resembles the popular Total Quality Management (TQM) program. Many of the tools such as employee empowerment, benchmarking, documentation, etc. used in TQM are used to implement and optimize TPM. Following are the similarities between the two.

1. Total commitment to the program by upper level management is required in both programmes
2. Employees must be empowered to initiate corrective action
3. A long range outlook must be accepted as TPM may take a year or more to implement and is an on-going process. Changes in employee mind-set toward their job responsibilities must take place as well.

\textsuperscript{13}http://www.elprisma.com/apuntes/ingenieria_industrial/tpmmantenimientoproducivototal/
There are also differences between TQM and TPM which are summarized below.

<table>
<thead>
<tr>
<th>Category</th>
<th>TQM</th>
<th>TPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object</td>
<td>Quality (Output and effects)</td>
<td>Equipment (Input and cause)</td>
</tr>
<tr>
<td>Means of attaining goal</td>
<td>Systematize the management. It is software oriented</td>
<td>Employees participation and it is hardware oriented</td>
</tr>
<tr>
<td>Target</td>
<td>Quality for PFM</td>
<td>Elimination of losses and wastes.</td>
</tr>
</tbody>
</table>

Tab 2. Difference between TQM-TPM

There are different kinds of maintenance as we can see afterwards:

1. Breakdown maintenance: It means that people waits until equipment fails and repair it. Such a thing could be used when the equipment failure does not significantly affect the operation or production or generate any significant loss other than repair cost.

2. Preventive maintenance (1951): It is a daily maintenance (cleaning, inspection, oiling and re-tightening), design to retain the healthy condition of equipment and prevent failure through the prevention of deterioration, periodic inspection or equipment condition diagnosis, to measure deterioration. It is further divided into periodic maintenance and predictive maintenance. Just like human life is extended by preventive medicine, the equipment service life can be prolonged by doing preventive maintenance.
   - Periodic maintenance (Time based maintenance - TBM): Time based maintenance consists of periodically inspecting, servicing and cleaning equipment and replacing parts to prevent sudden failure and process problems.
   - Predictive maintenance: This is a method in which the service life of important part is predicted based on inspection or diagnosis, in order to use the parts to the limit of their service life. Compared to periodic maintenance, predictive maintenance is condition based maintenance. It manages trend values, by measuring and analyzing data about deterioration and employs a surveillance system, designed to monitor conditions through an on-line system.
3. Corrective maintenance (1957): It improves equipment and its components so that preventive maintenance can be carried out reliably. Equipment with design weakness must be redesigned to improve reliability or improving maintainability.

4. Maintenance prevention (1960): It indicates the design of new equipment. Weakness of current machines are sufficiently studied (on site information leading to failure prevention, easier maintenance and prevents of defects, safety and ease of manufacturing) and are incorporated before commissioning a new equipment.

2.2.6. Single Minute Exchange of Die (SMED)

SMED is a tool Lean Manufacturing essential in the current framework of the productivity of a company. Precisely SMED is born from the need to adjust to the flexibility currently companies need in terms of demand. This needs pass reduce the size of lots, lean manufacturing, stocks and thus minimize is critical to minimize both the time changes as tools for machines preparations.

Minimize setup time of machines and materials, this philosophy is essentially SMED. Today is not only a commitment to minimize preparation time, but also repair times and maintenance.

While there are a number of techniques designed to increase or improvement productivity and SMED merits special consideration is important for three reasons:

1. Generally the production lots are large because the Switching time is high and, therefore, the inventory investment is high. When time is insignificant change can occur daily amount required, eliminating almost entirely the need to invest in inventories.

2. The quick and simple methods eliminate the possibility of change errors in the tool settings and useful. New methods of change substantially reduce defects and eliminate the need for inspections (Quality improvement).

3. With rapid changes can increase the capacity of the machine without need for investment in new machinery. If the need for machines is greater than 100% capacity, one option for more capacity, is to reduce changeover time and preparation.
Before starting this working method it is necessary to use various techniques for the study:

- **Pareto Analysis**: This technique is intended to distinguish the trivial from the vital. So concentrate on those few activities that absorb most part time exchange and/or preparation.
- **The five why successive**: for the purposes of detecting opportunities. However, simplification or elimination of tasks involved in the process of changing tools or equipment preparation machines.

Sometimes, actions performed daily by both plant personnel and responsible become absolute truths and there are not questioned. These techniques attempt to question these actions and how they are performed in order to determine whether, on the one hand are vital and on the other hand, being vital, if they are made in the best possible way.

### 2.2.6.1. Basic concepts of SMED.

When a change occurs in a machine model production there are perform some operations including the preparation tasks and adjust of the machine done before and after processing each batch. These operations can be classified into two types:

- **Internal**: Includes all activities for the realization of which the machine or equipment must be stop.
- **External**: Includes all activities that can be performed while the machine is running.

This same technique applied to the preparation of equipment, machines or lines production for exchange activities or product model and also during execution of the maintenance (such as the preventative maintenance) can lead to reduce by 60% the scheduled downtime machine.

To apply this technical is necessary to execute the steps described below:

- **Mixed Phase** (Separate internal and external preparation): The first step and perhaps the most important. As a first step to improve time preparation is to distinguish the activities that are carried out: External and internal preparations.
The time is reduced by eliminating the internal time preparation, so all tasks that can be performed while the computer is running must be done in this time. Time reductions can get up to 50%.

- **Phase division** (Convert internal preparations to external): The methods listed below may be used to convert preparations internal activities for external:
  - Preassembled.
  - Using standards or templates quickly accommodated.
  - Remove the settings. Set constant values that allow rapid interventions.
  - Use intermediate templates. To remove small loss of time is necessary to consider the following questions:
    - What preparations need to be made in advance?
    - What tools should be done by hand?
    - Are the tools and templates in good condition?
    - What type of work table is necessary?
    - Where should be located the templates after being used?

There are three simple rules to keep in mind when trying to improve times intervention:
- Not to search for parts tools.
- Don’t move things unnecessarily, set the table and working Storage area properly.
- Don’t use the wrong tools or spare parts.

These rules are related to the first 2 stages of the application of the 5S: Seiri (classification) and Seiton (order). Implementing improvements discovered for this type of questions, you can reduce the preparation time a 30-50%.

- **Phase transferred** (Improve aspects of operation preparation): This stage is to improve every elementary operations. Although it is recommended to be systematic, this stage is usually done with the second one. To be able to reduce or improve operations these questions must be answered:
  - Is the task necessary? Can it be removed?
  - Are current procedures appropriate? Are they difficult?
  - Can you change the order of tasks? Can be made simultaneously?
  - Is the number of people working appropriate?
  - Which is the workload of those who are involved the machine?
Once the above analysis, the goal is to focus on optimizing initially removing, unnecessary adjustments and subsequently improving inevitable adjustments:

- Remove settings. Many settings can be executed without trial and error, only the inevitable adjustments must remain. To delete adjustments is necessary to analyze its purpose, causes, current methods and effectiveness.
  - Investigate causes. Identify why adjustments are needed.
  - Consider alternatives and improvements that eliminated the need for make adjustments.

- Improve inevitable adjustments. When the settings are not eliminated, several strategies can be adopted:
  - Select values defined. Using constant values for avoid adjustments; consider measurement methods for evaluating securities numeric.
  - Establish a standard procedure to execute the settings.
  - Improve the skills of workers practicing procedures.

After going through these three stages of improvement in the implementation of the SMED\textsuperscript{14} the machine preparation time must be reduced, so production lines will have greater availability, being able to work with smaller lots.

- **Improved Phase** (Suppress own preparation). For the purpose of full replacement of the preparation, may be adopted two criteria. The first is to use a uniform product design for different products, and the second approach is to produce the different parts at the same time.

The graph shows the reduction of time depending on the implementation of the different phases. Clearly, not in all cases it is possible to achieve the percentages indicated in the figure.

\textsuperscript{14}http://gestempresas.blogspot.com/2009/01/smed-en-ferrari.html
Final Project.

Implementation selected tools of Lean Manufacturing

Fig 9. Phases of SMED
2.2.6.2. Application techniques.

They are used in the SMED six techniques that give effect to the four concepts outlined above.

1. Standardization of external preparation activities. The operation of preparation tools, tools and materials shall have common and standardized procedures. Such standardized operations must be written and attached to the wall so that the operators can be able to see. Then, workers must receive the corresponding training to master with.

2. Standardize only the necessary parts of the machine. If the size and shape of all the tooling is fully standardized, the preparation time is reduced considerably. But since this is a high cost, it is advisable to standardize only the function necessary for the preparations.

3. Use a quick fastener. Although the clamping element most widespread is the bolt, there are various elements allowing a more effective and efficient grip. Such items are the use of pear-shaped opening, the U-shaped washer and the grooved nut.

4. Use a complementary tool. The machine should join a complementary tool in the external preparation, and then the internal preparation tool set in the machine can be nearly instantaneously. To make this possible it is necessary to standardization of complementary tools.

5. Make use of parallel operations. There are preparation operations machines which occupy a lot of time to the operator. But, if you proceed to apply to such machines parallel operations made by two people at the same time, useless movements and can be removed and reduced preparation time.

6. Use of a preparation system mechanics. Make use of Hydraulic or pneumatic systems to facilitate adjustment in case it is necessary.

2.2.7. Supply chain management. Kanban

Kanban is a fundamental tool in JIT philosophy that is implemented with other terms such as good organization at work, cards and production through the production flow for optimal results of equipment performance with minimal waste. Kanban is a system that controls the flow of process resources production through cards, which are used to indicate material supply or production of parts. This tool is based on customer demand and consumption, and not in demand planning. Can also
be understood as a system of production that determines the flow of materials through signals that indicate when a product must be produced and when we need to replenish raw materials between two workplaces that are consecutive. A kanban is characterized for having associated a set of a particular type of products and is defined as text, image, barcode, etc.. Each lot must have assigned a specific amount and may add other useful information, such as the identification of related processes, source-end, type of product packaging where the material should be placed in the area of storage. Ultimately Kanban label contains information that serves as an order of work, this is their primary function. In other words, is an automatic direction device that gives us information about what to produce, in what quantity, by what means, and how to transport it.

Typically there are two main kinds of Kanban:

1. Production Kanban: A signal from the internal customer to the internal supplier that something is required from the internal supplier.
2. Withdrawal Kanban: A signal from the internal supplier to the internal customer that the supplier has produced something which is available to be withdrawn by the internal customer. In such case the internal supplier doesn't produce more until the withdrawal is made by the internal customer.

In the diagram below we can see the two types of kanban specified above.

![Fig 10 Types of Kanban](image)

To ensure the smooth operation of the system is necessary to have clear two fundamental principles:

1. The production control: Production control means the integration of the different processes and developing a JIT system in which materials arrive in time and amount required in the different stages of manufacture. In the field of operating, small and frequently deliveries are the key to the system. The proximity
between centres is, therefore, a very important element, as improves control, communication, cost and timeliness of transactions, thereby maintaining minimum input inventories. The requirements terms of quality and timeliness come to the fore due to the short range of overproduction.

2. Continuous improvement: Function improvement of processes means improving the different activities of the company by using Kanban (done by engineering techniques). These techniques were looking to achieve the following results:

- Elimination of overproduction and waste.
- Power starting any standard at any time.
- Give instructions based on the current conditions of the work area.
- Prevent unnecessary work being added to those orders and started and prevent excessive unnecessary paperwork.
- It facilitates control of the material.
- Organization of the work area.
- Reduced set-up (model change).
- Reduced WIP (Work in Process).
- Management multiprocessing.
- Error-proof mechanisms.
- Preventive maintenance.
- Reduced inventory levels.

It should take into account the following considerations before implement Kanban:

- Determine a production scheduling system for developing mixed production system and labeled before implantation Kanban full to smooth the current flow of materials.
- Establish a route Kanban which reflects the flow of materials, this implies designate places to avoid confusion in handling materials. It should be obvious when the material is out of place.
- The use of Kanban systems is linked to small batch production.
- It should be noted that those items of special value should be treated different.
- You must train all personnel to be able to operate with Kanban system. This point is vital for the future of the new system.
Using a Kanban system promotes improvements in two aspects:

1. The Kanban exposes abnormal situations that are caused by breakdowns of machines and product defects.
2. A gradual reduction in the number of Kanbanes leads to reductions in stock, which ends with the role of stock as buffer against production instabilities. This reveals the processes that generate anomalies and simplifies the points for improvement. The overall efficiency is increased by concentrating in weak elements.

One role of Kanban is to transmit the information to the process previous to know which the needs of the current process are. If there are many Kanbanes, the information is no longer as effective, because you don’t know which parts are really needed.

**2.2.8. Overall Equipment Effectiveness**

The machines are designed in order to be able to fulfil a certain production capacity. In reality, and for different reasons, the production always lags behind the capacity for which it was designed. Furthermore, it seems that the implanted improvements have little effect on productivity. The higher the production speed is, more products are rejected, and when we focus more on quality, the machine does not work as expected.

The OEE provides insight about the losses that occur during the manufacturing process.

If the production of approved products lags behind installed capacity, we talk about hidden production capacity (this capacity is not being used for the production of good). OEE allows us to identify the losses by comparing the performance of different machines with an ideal machine (a machine that works as long as we want, at top speed and producing only good to the first). These losses can be divided into the following factors:

- Availability: How long has been running the machine or equipment versus time that should have been operating (removing unplanned time)
• Performance: During the time it has been running, how much you have produced (good and bad) regarding what had to be made to the ideal cycle time.
• Quality: The indicator known by everyone. How much I have made good on the first of the total production performed (good and bad).

The OEE indicates how effectively the machines are being used compared to the ideal machine (OEE = 100%). The figure below illustrates how to determine the OEE.

![OEE Formula](image)

Actually the OEE value is much lower than expected. The difference between the ideal and the reality is equal to the sum of the losses and, consequently, shows exactly where we should implement the improvement.

You can't improve what you can't measure, that is why the improvement process always starts with measuring OEE since the OEE is a very powerful tool to find where the losses are.

When analyzing OEE, many companies may be surprised to find that there is significant room to increase the output of certain pieces of equipment. For example, they may be able to minimize:
• Unnecessary equipment breakdowns.
• Downtime due to set-up and adjustment.
• Idling and minor stoppages due to lack of raw materials to process due to bottlenecks or poor production planning.
• Operation below maximum designed speed due to poor operator efficiency, maintenance constraints or other factors.
• Defects that require re-processing.

Tracking OEE is helpful for identifying the sources of bottlenecks, for making capital spending decisions and for monitoring the effectiveness of programs to increase machine productivity.
CHAPTER 3:
CHARACTERISTICS OF THE COMPANY
3.1. Description and location

In order to implement the above techniques I decided to select a bottling of alcoholic beverages called Teichenné. Here below is detailed some of the history of this company and its evolution during his lifetime.

TEICHENNÉ , Inc. is a family business dedicated to the production of liquors and derivatives. It was founded in 1956 by the father of the current manager and company president, John Teichenné. At that time the production was entirely handmade and very limited, sales were confined to regions closer. It was not until the '70s, when Teichenné, SA expanded, coinciding with the moment when John Teichenné replaced his father. The challenge was to create a wide range of products, taking into account the presentations and offering the best quality.

Thus began the position in the Spanish market and there was a "Boom" when where introduced into the market the Teichenné acquaintances "Schnapps", sweet liqueurs flavored with Fruit of medium graduation that represented a novelty in the late 80s. These new liqueurs opened the door to new exports, which has grown since then arithmetically.

This constant growth in production made Factory L’Arboç, the family's hometown, too small to be able to satisfied all the necessities and was in 1993 when new facilities were built in Bellvei Penedès. Between these two factories nowadays Teichenné have a catalog of over 200 products and is exporting to more than 25 countries.

In this project we focus only on the plant in the Arboç, specifically Km.1194 Crta N-340, 8 Bellvei del Penedès. Below is an image where point A is the factory
The company cares for spreading their organizational principles, its mission, vision and objectives are described below:

**Mission:** To be one of the first consumer products companies worldwide. Provide opportunities for growth and enrichment to employees, business partners and communities in which the company operates. And throughout, cultivate honesty, fairness and integrity.

**Vision:** The liability of the company is to continually improve all the appearance, environmental, social and economic world in which it operates, creating a better tomorrow than today. The vision springs into action with programs focusing on environmental stewardship, activities to benefit society, forming a truly sustainable company.

**Objectives:**

- Obtain customer satisfaction through the quality of service and compliance calendars and schedules at the beginning of each cycle.
- Achieve staff ownership and commitment to the company likewise, promote respect between employees and customers (Promoting human resource development).
- Develop action plans related to Quality services and continuous improvement of processes.
- Raising levels of efficiency and productivity with responsibility and fulfillment of obligations.
- Establish security policies for the benefit of workers.
- Get the best value in the operations of the best manner.
Below is a map of the factory. As we can see it has two floors, on the ground floor is produced the process of filling the bottled and on the first floor it is produced the mixture. On the front of the factory are located the offices and on the back is the area of production and storage.

Fig 13. Diagram of the factory
3.2. Description of the process

To be able to find the weaknesses of our production line, those points where there are problems that can be solved by any of the techniques discussed above I must first explain the operation of the factory.

The factory receives eight types of raw materials: alcohol, sugar, flavorings, empty bottles, boxes, seals, labels and caps. Using a mixture of alcohol, sugar and flavorings, we obtain the desired type of liquor by the formula used. Alcohol is received by truck and discharged by pumps up the four tanks at the ship dock. Moreover, both sugar and flavorings come in vans that are downloaded manually and using a forklift it is transported to the first floor where is performed the mixture to obtain liquor. The other five types of raw materials arrive by truck and unloaded by lifting bulls to the store entrance.

The factory produce two different types of liquor, the manufacturing process is the same for both lines. Each line has a conveyor belt that moves the empty bottles and passed through the different machines as explained below.

The process has several entry points of raw materials. On one hand, the cardboard caps, seals, labels and plastic packaging arrive to the dock and are downloaded in the store. Empty bottles come in by trucks, packed properly to avoid damage during the transport, and are stored in the warehouse entrance. Thus, the process begins with manual unpacking bottles.

Once this process finish, using a forklift truck one operator takes the empty bottles to the initial part of the conveyor where two operators are in charge to position the empty bottles in the conveyor as it advances. When the pallet is empty it is carried to the end of the conveyor to be able to reuse it placing there the full bottles. Moreover, an operator is responsible for carrying each material to the different machines and put them in a correct way to be able to perform correctly the bottling fill.

Parallel to this process, in the laboratory there is make the production of the desired liquor. The sugar and flavorings are downloaded manually and using a forklift are transported to the first floor. Alcohol is discharged, through a pipe, from the truck to the four storage tanks, and then transported by pumps to the tanks at the first floor. It is at this point where following the formulas derived in the laboratory, mixing alcohol, sugar and flavorings it is produced the desired liquor. Below the mixture there is extract a sample to make the quality control. If the mixture is satisfactory by some pipes located on the floor of the first floor, thanks to gravity, the liquor descends reaching the bottling
machine, and poured into the empty bottles the mixture of alcohol, sugar and flavorings.

The filling machine is the first of the various machines which are in the process. Once the bottles are filled there are placed back on the same conveyor belt to be guide towards the machine that puts the plugs. After the placement of plugs, there is a machine sticking labels in both sides of the bottles. In this last step, the bottles must be dry because if not labels wouldn’t stick well. At the end of each conveyor belt there are two operators who are responsible to place the filled bottles in the appropriate boxes and these boxes are placed in pallets. To finish the process, once the boxes are placed in the pallet, one operator transports them to a rotating platform where another one will package them carefully. Finally, once they are well packed they are transported to the warehouse where they are stored.

In the Annexes we can see the different machines that take part in the bottling process. To be able to understand better the process there is a scheme below.
Fig 14. Diagram of the bottling process
It is also interesting in order to understand better the whole process, see the flow chart of the materials within the factory. The diagram above is the factory floor and the lower diagram is the elevation.

![Flowchart](image-url)

**Fig15. Flowchart**
3.3. Description of the problems

For the identification of the current problems in the company, were performed visits to the bottling plant in this manner was observed all stages of the production process, and interviewed operators (shifts morning and evening), the Plant Manager and the Production Manager. With the data and information collected, we have determined the critical problems in the factory. Most of the problems identified have been increased due to the crisis that is affecting Spain.

The first problem we found was the overproduction. A few years ago there were no problems in producing more than necessary because demand was much higher, but today we want to attempt to match production with demand. Therefore, we must create proper planning to not to obtain a high quantity of stock. This will lead to prevent the company of possible cases of inefficiency or unexpected problems in the process.

Another problem we observed was the inefficiency in storage both outbound and inbound. This is because when unloading boxes with raw materials, not taken into consideration when you are expected to use these materials, and therefore are placed randomly. This causes that the operator takes much longer to locate the materials they need and thus delay the process. Something similar happens in the stock output, as the boxes are not placed in order of departure. On the picture you can see the disorder that exists on the stores.

Fig 16. Picture of the storage
It has also been observed that in the production process a lot of time is lost in transporting the defective materials to the recycling point. This point is located outside the factory, so a possible improvement would be to move the recycle bin to a nearest point. We would also have to do a study on the amount of defective raw material that arrives at the factory, and do a market study to decide whether to switch suppliers or not. The following image shows the recycling bin.

Fig 17. Recycling bin

Another issue that has come up is the great loss of time that occurs in the raw materials exchange both in the capping and labeling machines. As everyone knows each bottle has its own brand with different caps and labels that makes the difference. Below is shown the capping and the labeler machine.

Fig 18. Capping and labeler machine
Were also identified a number of improvements that could be made that are not properly problems but that could improve the quality of the job of the operators and accelerate the production process. For example, a table could be placed at the end of the conveyor to place the bottles inside the boxes and so the operator would not need to bend down. This would improve the quality of their jobs and would be reflected in their attitude. Another measure that could be taken is increasing the maintenance of the machines creating a preventive maintenance plan for the machines do not suffer so many breakdowns. As well as create a method of operation in case of trouble unexpected occurs.

Thus the outstanding problems can be summarized as:

- Overproduction problems. It is necessary to rethink the production planning
- Misuse of storage space leading to loss of time and thus slows the bottling process
- Loss of time in transportation and material exchange
- Too much raw material waste which leads us to rethink whether the supplier is right

The following section will present the different measures that can be taken to be able to improve our process.
3.4. Proposal of improvements

The company's goal is to improve every day to get a better quality for the product to satisfy customers. To achieve this improvement will follow kaizen philosophy.

The measures to be taken to be able to improve the problems outlined above will be:

- **5S’:** It allows us to create a formation of habits of cleanliness and order that will be passed on process improvement.
- **Poca Yoke:** Different device designed carefully in order to avoid errors in the operation of a system.
- **TPM:** The aim is to reduce both the cost and waste, using preventive and corrective maintenance.
- **Kanban:** A system of cards that are stick in the containers that detach when these containers are used to ensure the replenishment of such materials. The cards act as witness the production process.

3.5. Implementing improvements

This chapter details how will be implemented the different tools to achieve the desired goals.

3.5.1. Implementing 5 S’ in Teichenné

The Workspace organization or 5S methodology is a technique that seeks to achieve a working environment clean and stable. The steps to follow are:

1. Seire → Sort: Remove what is unnecessary, reorder needed most to least important and prevent disordered again.
2. Seiton → Order: Everything has a place and needs to be in place.
3. Seiso → Cleanliness: Identify and remove dirt.
5. Shitsuke → Discipline: Getting the improvements made through the 5 s are a habit and used established methods.

Here we present the improvements implemented in the company Teichenné:

- **Seire**

As stated above one of the problems that has our company is the great disorder of storage as shown in Fig 16.
To achieve a better distribution is necessary to make a thorough examination and find those materials are stored to be used not more either because they are outdated or no longer manufactured because such bottles. We also need you establish an order in both stores placing the materials most used in the closest points, thus reducing production time and placing less used materials in the top shelves. Later in the implementation of kanban process should contain a methodology for achieving this purpose. You also need to clean the area of production and because if there are things that are not worth the ground can cause injury to operator, pollution, reduces the accuracy and quality of the process and it can even prevent access to certain machines that can lead to production delays.

- **Seiton**
  One of the main problems found daily by the operators is that they produce a large amount of plastic and cardboard waste during the process of unpacking raw materials as these are contained in boxes. Also as discussed above there are many materials that are in bad condition, broken or defective. As discussed in the description of problems that has Teichenné, recycle containers are placed outside the factory (Fig 17) and this causes a great waste of time since the operators, to maintain a clean working environment, every time that unpacks something have to travel around the installations until arrive to the container to throw it. This problem is easily solved by placing the container area, for plastic and cardboard, inside the factory near the place where operators make the unpacking.

- **Seiso**
  To achieve a good final product quality is necessary that the work environment is clean. Thus it is very important as we have said previously that all the wasted materials must be thrown in the containers. It is also necessary that the machines are clean, every time you change batch, in other words when you change the liquor, employees must be sure that the filling machine is cleaned to ensure that the flavors not to be mixed. To make this process must follow the instructions detailed in the sheets that are posted in each of the machines. And above all, be sure when performing these tasks that the machines are unplugged.
The following image shows the instruction sheet for a correct cleaning.

![Instruction Sheet](image)

Fig 19. Instruction sheet

You have to scrub the floor as often poured liquid and may be dangerous for operators as they may slip and hurt.

- **Seiktsu**
  
  This step is one of the most difficult because once you have managed to put everything in order, it is difficult to maintain. One way to achieve this is to talk with employees and accustom them to carry out all operations properly complying with the policies outlined in the previous sections. It is very important that they get used to doing things right, listing everything that they think is not right or that could be improved.

- **Shitsuke**
  
  To conclude, we should monitor employees to ensure compliance with these new changes, to finally get them to be their own supervisors. This we achieve by tracking weekly to each of the operators which will explain the problems that have arisen during the week. In these interviews will also be assessed progression of operators.

### 3.5.2. Implementing Poca Yoke in Teichenné

After visiting the factory we focus how to improve the production process. The bottle filling process is a very compact since no operator is required to take care of moving the bottles. There is a conveyor belt that transports them from one machine to another. The problem arises if there is some unexpected damage in a bottle.

For example we see that a point that could be improved would be the implementation of a sensor that would measure the filling of the bottle to make sure that everyone gets
the same amount of liquid. This sensor would be place on the conveyor belt and through a beam function would measure the amount of liquid that the bottle has. It consists of two devices, a sender and a receiver. The transmitter will send a beam of light, if the receiver receives it means that the bottle is properly filled, if the receiver doesn’t receives anything an alarm turn on indicating that the bottle is too full. At that time the conveyor belt is stopped and an operator takes care of removing the bottle. The sensor that has been chosen is shown in the picture.

![Detection sensor](image)

**Fig 20. Detection sensor**

Another detection device that can be placed which is very visual detection is a traffic light. The function of this would alert the operator if a problem exists in one machine. The traffic light will have three positions, if the process is in operation the green light will be on, if there is any problem with one machine the traffic light is red and if the machine is not in operation will both leds off. The device that is selected is as follows.

![Detection device](image)

**Fig 21. Detection device**
3.5.3. Implementing Total Productive Maintenance in Teichenné

Whereas in most production settings the operator is not viewed as a member of the maintenance team, in TPM the machine operator is trained to perform many of the day-to-day tasks of simple maintenance and fault-finding. Teams are created that include a technical expert (often an engineer or maintenance technician) as well as operators. In this setting the operators are enabled to understand the machinery and identify potential problems, righting them before they can impact production and by so doing, decrease downtime and reduce costs of production.

Note that the 5S tool is closely linked to TPM as largely helps to observe anomalies because after cleaning the machine is much easier to perform a visual inspection of the machine and discover possible errors.

Maintenance is a concept closely aligned with the quality. Must be at the origin, in other words in the machine, where achieves a zero breakdowns and not through some maintenance activities that use the system to putting out fires. For a company to survive, in an increasingly intense competition, maintenance activities should be incorporated wing definitely achieving manufacturing excellence.

Teichenné currently don’t have preventive maintenance culture. Normally maintaining the machines is performed corrective type. It is at this point that we want to improve the process by creating a habit of preventive maintenance which helps detect problems.

First of all there will be a study of the operation of the machines and the damage they have. In the picture is shown below where the blade will describe the problems encountered.

<table>
<thead>
<tr>
<th>Type of machine</th>
<th>Time breakdown</th>
<th>Level of breakdown</th>
<th>Description of the fault</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>weak (1-5min)</td>
<td>impairment (6-15min)</td>
<td>severe (&gt;15min)</td>
</tr>
</tbody>
</table>

Fig 22. Monitoring Worksheet of breakdowns
Once monitoring for a month, we will know which machines are those that break down more often and from there create a preventive maintenance plan to try to avoid these breakdowns. Monitoring will continue doing from now on as because new errors may arise to be modified. Below is shown a possible preventive maintenance plan.

![Preventive maintenance plan](image)

**Fig 23. Preventive maintenance plan**
As we can see the maintenance plan shall include a schedule when each action should be performed at each machine component that must be done, what is the goal you want to achieve with this measure and ultimately who should carry it out.

We also believe it is appropriate to make a study of the quality of raw materials as visited the factory when we realized that many are in bad condition. So also will create a tracking sheet from defects in materials where operators will mark the number of defective parts. When we get the results we can consider whether you need to change supplier. The following image shows a possible tracking sheet.

![Tracking sheet to study the quality of raw materials](image)

Fig 24. Tracking sheet to study the quality of raw materials
3.5.4. Implementing Kanban in Teichenné

Kanban is a system that controls the flow of process resources production through cards, which are used to indicate material supply or production of parts.

The first thing we will implement is the use of some adhesives that will be glued to the boxes of raw materials. The operator which is responsible for downloading the raw materials will become the responsible for completing these cards and paste it correctly. The cards that will be used will look like that one shown below.

<table>
<thead>
<tr>
<th>Appearance</th>
<th>Parte Nº</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Brand Name</td>
<td>_ / _ _ _ _</td>
</tr>
<tr>
<td></td>
<td>N. container</td>
<td>_ / _ _ _ _</td>
</tr>
<tr>
<td></td>
<td>Container Capacity</td>
<td>_ / _ _ _ _</td>
</tr>
<tr>
<td></td>
<td>Lot No.</td>
<td>_ / _ _ _ _</td>
</tr>
</tbody>
</table>

Thanks to the date of bottling the operator will be able to place these boxes in the storage in order to make it easier to locate later and therefore not lost much time when going to look for them.

At the moment the box is used, the raw materials are placed in their respective machine, the cards are carried off to the end of the process. This is where the workers in charge of putting the bottles in their respective containers realize what kind of box and packaging needs and are going to pick them up. Every time that one material is used an email is sent by internal mail to a database. The commercial will use this information to talk with materials suppliers to ask them for materials needed and in what quantities. This is a Pull phase, because when we spend a box we expect that another part will come for not running out.

Once the bottling process is finished and the workers have already put all the bottles in the boxes and that boxes on pallets, these are carried to be packaged. All this is done without losing the card that was placed at the beginning as this takes all the data from each type of bottle. Once packed the card is reattached and thanks to a reader all the
information is sent to the same database information mentioned above sending the information that the lot is already finished and can therefore come to be collected. This database is very important because if at some point for some reason we had any delay in production we would be able to advise customers that have not yet delivery list and so would save a trip in vain. Such actions favor us because if a client is expected to deliver a package and without warning is not given might decide to break the link between companies and obviously not interested in losing customers.
CHAPTER 4: CONCLUSION
Conclusions

Continuous improvement aim is to optimize processes by reduced costs, increased production and increased product quality and customer satisfaction, in this approach are based the proposed improvements to the most important problems determined in the diagnosis of the current situation of the company.

As has been shown throughout the different chapters, the company had many weaknesses and problems that through the application of various tools have been solved.

For example, before starting the study and make the appropriate changes considering kaizen philosophy, there was great disorder in the storage which made it difficult for operators tasks and thus slowed the process. After using the tools of the 5 S 'and Kanban has achieved a surprising improvement. The stores are clean and tidy and therefore it is easier for operators to find what they are looking for.

The card system has allowed us to create a database that shows where each material comes, when filling bottles occurs and day out. This database is very important for trade and negotiates with suppliers, because thanks to that commercials know how much stock is in each subject and so can make an order for the production tighter. Therefore there isn’t too much wasted space in the store because we don’t have so many stocks and this leads us to spend less money to get more benefit. Besides this database will allow us to always know which bottles were bottled and therefore to contact customers in case there was some delay or a problem with a batch.

Another improvement that we have implemented is a preventive maintenance plan. Any company that wants to be competent today in the labor market should own one. Do not wait for something to be broken, the best way to fix it is to not let it happen. If you create a preventive maintenance plan and still can get many benefits for the company. Less money is spent on repairs, you get a lower production time and therefore more efficient, it can produce more in less time so we can provide more customers.

In summary, we have managed to implement improve in the production process and also getting problems partially disappeared due to the implementation of Kaizen. But
do not forget that this system is a system of continuous improvement, every day you should try to find new targets that achieve improving our process.

Thus as we follow the Kaizen philosophy in future the company should consider using other tools of lean manufacturing that have been exposed in this project. It could get a great improvement if we applied the tool of Single Minute Exchange Die (SMED). With this improvement, the external processes would get internalized and therefore minimize production time. As explained above can save up to 90% of the time that is currently used. I think this measure would be useful for our company.

You could also try to implement the system of Overall Equipment Effectiveness. This tool is what we achieved to know the effectiveness of each machine and so what we get is a better production with higher quality. We could identify if there is any machine that has some kind of problem and if necessary consider changing it.

Another tool that I think can be usefully applied in the future is Value Stream Mapping. They try to make a graph showing all the activities carried out as well as different customers and suppliers. Once done this graphic, we should try to improve the activities that generate a lot of waste. This tool will allow us to improve the production process.

These three tools I believe could be useful in the future for our company but we must remember that there are many others. And we should notice that any small change can improvement a lot our production process, and this philosophy of lean manufacturing includes the entire company which requires commitment, effort and dedication, this leads to great results in the company, and provides great satisfaction to employees and managers, for improving the work environment.
CHAPTER 5:
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- Website of the Company : [http://www.lean.org](http://www.lean.org)
CHAPTER 6: ANNEXES
These are the different machines that take place in the filling bottle process.
Implementation selected tools of Lean Manufacturing