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APPLICATION OF THE SMED TECHNIQUE TO REDUCE SET UP TIMES IN THE COSMETICS INDUSTRY. THE L'ORÉAL CASE

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INTRODUCTION

This thesis aims to describe, analyse and apply Lean Manufacturing concepts and tools, in order to demonstrate its usefulness, especially in production plant applications. In particular, the most important goal of the thesis is to achieve a setup time reduction in both cleaning and technical / mechanical changeover through the Single Minute Exchange of Die (SMED) technique by Shingo (1985) in order to gain valuable time to increase quality standards and time for production. The thesis study was conducted as production engineer intern in the Settimo Torinese plant (Cosmetics powder production unit) of L'Oréal cosmetic firm during the period between October and April of 2018. The methodology applied consists in collecting the necessary data of the processes, handle them rearranging in a clear format useful for the analysis in order to visualize the constraints, highlight strengths and weaknesses of the processes and both separate and switch external and internal activities applying SMED technique by Shingo. Lean Manufacturing is not a novelty, since it appeared in the middle of the past century, but this field is still unknown for many firms which still find difficulties in its implementation. For many logistical and organizational reasons, several firms do not make their businesses with a Lean attitude because, in order to apply it, it is necessary the involvement of the all stakeholders and it is often needed a re-arrangement from the foundations of the firm, a compromise that is not always approved by senior managers and CEO. The Lean implementation should go hand in hand with the development of the firm since its beginning otherwise it will be hard to change mental attitude and layout structures both necessary to the transformation. The cost to implement a Lean behaviour related to the switch from a non-Lean firm to a Lean one is directly proportional to the time wasted in not applying this strategy. On the contrary, the application of the Lean Manufacturing method allows to save a lot of money by implementing and maintaining the results achieved over time. The best advantage of the Lean is that it does not require too many investments in innovation and technology, but it is based on its application finding easy and not expensive solutions [12]. Most firms just adopt some tools and adaptations of Lean principles not covering the entire supply chain structure resulting in a non-effective exploitation of the potential benefits. For instance, the implementation of some easy tools as 5 Standards (Paragraph 1.2.3) or Visual Management (Paragraph 1.2.4) without doing nothing more would be like "To tidy up chairs of Titanic deck" (Bicheno & Staudacher, 2009). Nowadays, it is crucial for a firm to implement the Lean for achieving and maintaining best manufacturing practices and competitive advantage aiming to compete against the other players in the market. The thesis starts by making a fundamental constraint to the analysis: for practical reasons, such as the limited time spent for conducting the thesis which does not allow further insights, the text focuses on the achievement of competitive advantage by minimizing setup times through the SMED application. The novelty resides in the fact that the firm faces the technical changeover on a new product format for the first time. The implementation of Lean Manufacturing philosophy would result very effective only after having analysed the entire value-chain (Or product value-stream) through the Value Stream Map tool (Paragraph 1.2.2), opportunity which is not feasible due to the restricted thesis time. Furthermore, in paragraph 1.2.1, it will be seen that in the analysed firm, the application of Pull System, which allows to produce following "Just In Time" principles, is hard to deploy since in large consumer cosmetic industry is impossible to catch the customer demand at a reasonable lead time starting from Pull System. In practise, the weakness of the Pull / Kanban System is the assumption of levelling production stabled over time; if the demand is not constant and there are high fluctuations, large buffers would be forced to detain and the synchronization among phases will result impossible. Then, it is preferred to achieve a large production volume to fulfil the demand requested by the market. This is a further constraint in applying Lean Manufacturing which cannot be exploited to the fullest. That reason let to understand why Lean Manufacturing was applied first to the automotive industry. The main achievements of the thesis are essentially the reduction of setup times in both procedures, cleaning and technical changeover, in addition to an increase in quality standard related to the cleaning process of press lines. The first chapter, "The Lean Manufacturing", is going to provide a general overview of what Lean Manufacturing means, explaining the fundamentals, the most used tools and presenting four other industry applications (Apart from the cosmetic one which will be treated in the chapters 3 and 4). These other applications, exploited in paragraph 1.3, are useful in recognizing that the Lean Manufacturing does not work only in the production process but, it could be applied to other scenarios, such as service processes, because the Lean is not a specific tool but an attitude for doing better [14]. Instead, the second chapter, "L'Oréal", will give information about the history and the products of the firm, it will be analysed the policy adopted, the supply chain structure and the adopted Lean approaches of the L'Oréal Settimo Torinese plant. Chapters 3 and 4 will be the thesis core. Within them, SMED procedures will be applied and the two case studies will be treated from both cleaning and technical point of view, constructing an AS-IS_TO-BE analysis. The last chapter will regard conclusions, such as thesis benefit and possible future steps for the firm.

1. THE LEAN MAUFACTURING

This chapter illustrates the main tools of Lean Manufacturing and how they can be used and managed to gain a competitive advantage with respect to the other firms which do not exploit these benefits. It will follow the history of Lean, fundamental concepts to understand for the implementation of it and other industry applications besides the manufacturing ones (Except the automotive case).

1.1 What is Lean Manufacturing?

The following paragraphs are going to be introduced wish to give a panning shot of what Lean manufacturing is. It will be introduced the pillars of the Lean and the essential parts of it, furthermore it will be illustrated the history of it, some definitions useful for the analysis, important features and key concepts of the Lean. In particular, it will be illustrated the concept of Muda which means waste and how it affects the approach proposed.

1.1.1 Definitions and History

“Doing more with less” (Bicheno & Staudacher, 2009). Maybe, this is the best definition of the Lean which continuously looks at the improvement of output without using unnecessary inputs. The Lean philosophy concentrates in doing the best with the highest quality (No waste) in the shortest time, maximizing customers satisfaction without production defects. Peter Hines talks about “Six Rights”: good cost, good product, good time, good place, good quantity and quality (Bicheno & Staudacher, 2009). It could be a rigorous goal and, of course, it is because in the real world there will always exist shortage capacity affecting the system where the product is produced and many failures primarily in human organization occur, leading to non-stop reworks in every field / department. The six rights rely on a variable definition of what could mean “good”, all these statements find a reasonable explanation by saying that “good” is the defined goal of the firm in relation to the benchmark and the industry.

“If the only tool you have is a hammer, it is tempting to treat everything as if it were a nail” (Maslow, 1966). It means continuously adapting own resources to the product required by the customer letting the production be consistent with the activities that must be done in order to fulfil the requirements. Using a metaphor, no one might produce steel with plastic tool. The concept must be intended not only in a physical way but also in the light of proper organization, proper information flow, proper competencies, etc.

Probably, Henry Ford was the pioneer of the Lean Manufacturing indeed during the first decades of XX century he thought that the use of interchangeable parts used in conjunction with standard work might be the key concepts of what he called “production flow”. Such pillars, which in widely terms stand for: standardization among shared resources, let the continuous flow of material among process steps in an interrupted line. All of that is standardized and perfectly known in terms of process knowledge, this leads to a reduced time to produce. The issue of Ford could be summarized in one word: Variety. Essentially without changeovers, the machines worked on a single part number with no possibility of customization or variety among the products [16].

Huge improvements will be made after the World War II thanks to Kiichiro Toyoda, Taiichi Ohno and others in Toyota which through simple innovations permitted both continuous production flow and variety in products. The paradigm of the production shifted from the focus on individual machines and their utilization to the one on product flow through the whole process. Only with right sized machines for the work to be accomplished, the introduction of self-check system and the correct schedule of the works is possible to produce more with less cost at the requested quality in time. The strong competencies owned in quick set up times are allowed Toyota to produce small volumes of many lots ensuring variety in fast time [5].

1.1.2 Features and Indicators

The Lean starts from simple ideas, through observations and learning kept together by working method and standardization. The goal of the Lean Manufacturing aims to value the performance for the customers by elimination of waste through shorter processes, allowing faster delivery, letting flexible manufacturing leading to higher capacities. Thus, better quality at a reduced cost by using simple machines over different models, enabling standardization so that minimizing the product quality variance.

Lean is “dynamic learning capability” that is the ability of a firm to learn by each event occurred, from the best to the worst one. In the light of this concept, issues could be an opportunity for developing and learning. Toyota often makes mistakes when it plans new products or plants, but its faster in recognizing them and improve the process for the next time so that them will not be present again (Bicheno & Staudacher, 2009).

From literature, among which those of Womack and Jones, Schonberger and many other authors (Womack & Jones , 2003) (Schonberger, 1986) (Bicheno & Staudacher, 2009), it seems that the Lean can be decomposed in 21 crucial features:

1. *Customer.* Is the starting point of the analysis, the value for the customer must be maximized, it should be done on the basis of the customer, not on the basis of internal operative activities.
2. *Purpose.* The analysis should be focused on the real final purpose which has to be recognized carefully.
3. *Easiness*. The simplicity is applied to the product through reduction of components and parts sharing or to the supplier’s point of view having few of them engaged.
4. *Waste*. Must be understood, recognized and decreased.
5. *Process*. Planning over process, follow the product flow not machine flow.
6. *Visibility.* Let the activities be visible and clear as more as possible in order to easily point out issues.

7. *Regularity*. This factor is related to visibility, it increases the easiness of underlying problems emerged just because they interrupt the regularity of the flow.
8. *Flow*. Capacity to synchronize all the activities of the entire process moving at the rhythm of the client.
9. *Uniformity*. To level the schedule, sell and purchase aligning them to the flow. All departments have to work at the same time in parallel.
10. *Pull*. Trying to work at the customer demand rate, avoiding overproduction.
11. *Postponement*. Delay all activities as late as possible tending to the pull system for reducing waste and risk and increasing flexibility.
12. *Prevention*. It is better to prevent future issues instead of facing them once they appear.
13. *Time*. Optimizing schedule, decreasing cycle time, working with parallel activities when they are affordable.
14. *Improvement*. Make always the best, continuously tend to perfection.
15. *Partnership*. Build strong relations with partners, suppliers and employees for increasing trust one each other. Look for Win-Win situation which lets every stakeholder to gain in each case.
16. *Gemba*. It means to manage situations in the production site not in the office, going to the physical place of the issue.
17. *Questioning*. Encourage culture and curiosity, rule of "5 Whys" (Paragraph 1.2.3) to understand the issue.
18. *Variability reduction*. Understanding natural variability and specific deviations in order to reduce uncertainty.
19. *Avoiding overloads*. It should be avoided both overloads and underloads, the former generates inventory costs, the latter generates unmet demand which is even worst (Customer loss).
20. *Participation*. Giving power to line operators to solve first issues, they could be the best resources for the specified problem.
21. *Think small*. Identify the less efficient machine and start to work on that, build and formalize step by step the problem starting from a single issue.

In order to understand on what the Lean is based it should be introduced some indicators, also called Key Performance Indicators (KPIs), which define the state of the system and give to the firm useful information for the realization of the Lean. These are [6] (Villa, 2016):

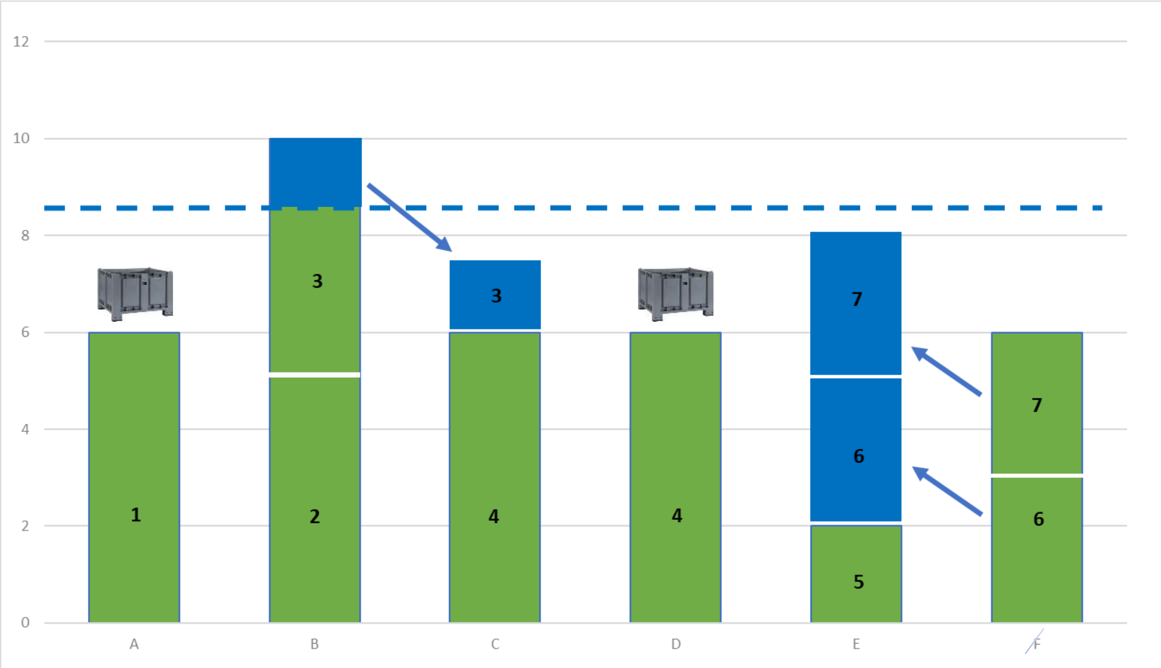
- *Cycle Time* = The period required to complete one cycle of an operation or to complete a function, job or task from start to finish [2].
- *Delay Time* = Is the period during which the unit waits for further processing.
- *Throughput* = Number of products per time-unit leaving the plant.
- *Flow Time* = Period required for completing a specific job or a defined amount of work [1].
- *Utilization* = Fraction of the available time the plant (Or machine) is processing items.
- *Work In Process (WIP)* = Number of items in the plant in a defined moment.

- *Effectiveness* = It is the ratio between the achieved goal and defined goal, it is a measure of achievement.
- *Efficiency* = It is the ratio of a defined quality objective in relation to the effort that is needed to achieve this goal.
- *Lead Time* = Time of product completion, from the request to the supplier to the customer delivery.
- *Takt Time* = The time imposed by the market to produce a product calculated as total time available above requested products by customers per day.
- *Pitch Time* = It is the takt time multiplied by the quantity of the package (Time to fulfill an entire box ready to deliver).
- *Scheduled Downtime* = Changeover times, maintenance, cleaning, inspections, product launch test.
- *Unscheduled Downtime* = Unexpected occurrences as stoppage of the facility, power blackout, delay from suppliers.
- *Process Rate Loss* = Process works at a lower rate than the originally planned.
- *Quality Loss* = Products that do not meet the requirements of the customer, reworks, contamination.
- *Uptime* = Products that come up the quality requirements.

To notice that the total cycle time has to be strictly lower than the takt time otherwise a firm cannot deliver the products in the time requested by customers, it is not said that cycle time will result lower than takt time, but it should be one of the most important goal to achieve to balance the production. The takt time is the net time available to produce depurated of scheduled maintenance time of the machines instead inside it should be maintained set up times and potential breakdowns in order to avoid distortions during the schedule, they are not avoidable and then are included on it. The paradox could lie in the situation in which, respecting takt time, a firm has to slow down speed lines to obtain an overall synchronization generating buffer at the end of those which go faster than the takt time. Probably, the takt time is the best time indicator of the lean philosophy which concentrates its efforts in reducing time and this calculation let us to balance the production ensuring the correct flow of the material / product. Not by chance, talking about Lean means going through the definition of “time economies” and not “scale economies” (Bicheno & Staudacher, 2009).

A time analysis (Figure 1.1) could simply be conducted as follows:

Figure 1.1 *Example of Time Analysis* (Adapted from L'Oréal internal source)



The graph above (Figure 1.1) is composed by time on the vertical axis and workstations on the horizontal one. Then, the highest cycle time at workstation B must at least be reduced to the target takt time. Merging workstations E and F to balance the workstations. Furthermore, the buffers at workstation A and D must be monitored and kept at a low level.

It is smart to balance the lines because it is better to have synchronization among them in order to guarantee time respect. It is easier to notice issues simply looking at the cadence, if all machines work at the same rate (Approximately) the one which goes longer is quickly pointed out, obtaining a better time response to problems. In a general view, working all together beyond the takt time let the firm to produce a product / service respecting the lead time requested by the market. The synchronization allows the continuous flow which in turn enables motion of products / services from one process step to the next one without idling or backflows (Re-works, for instance). Finally, a reduction in transport duration can be achieved by rearranging the flow of the work stations and working places or by changing the speed or distance of the transports.

1.1.3 Concept of "Waste"

Womack and Jones had begun their book "Lean Thinking" with the words: "Muda. It is the only Japanese word that must be known". Not by chance, in Toyota speak about 3 "M": Muda (Waste), Mura (Variability) and Muri (Overload). The relationship among these three definitions is based on the principle that overload and irregularity (i.e. variability) are the main sources of waste for the firm (Womack & Jones , 2003). The efforts of the firm have to focus on the reduction of overload, variability and waste in general. How it can afford this? Variability depends on the irregularity of the customer demand which often cannot be controlled, due to this reason a firm should not increase its own variability with wrong internal policies such as end month huge reports, discount prices, etc. The organization must be lean and it is better to frequently request small and constant lots by suppliers instead of less and irregularly big lots, trying to keep schedule on the machines as constant as possible maintaining rolling of the production flow. Overload is the second enemy. The overload on the machine must be avoided in order to not increase lead time and to have some extra-capacity for unforeseen events. Those two main concepts let us introduce other macro-sources of waste (Muda) strictly related with them. The practice of over-producing could be a double-edged sword because from one side it allows to cover some unforeseen events or an unexpectable increase in the demand, on the other side they increase inventory stock detained inside which implies higher (Inventory) cost. If these products result not saleable, they would directly affect the finances of the firm. The "wait" waste is related to the non-value activity concept, for every minute that the flow is interrupted for waiting, then the material and information flows are starved or blocked, then the lead time increases for the same amount of time, especially in those "bottleneck activities" which strongly determine lead time of production. Goldratt in his book "The Goal" said: "An hour lost for a bottleneck is an hour lost for the entire system" (Goldratt & Cox, 1984). The "motion" waste affects the layout of the structure, a bad layout in terms of cells or location of the tools put the operator in poor conditions with the consequences of getting bad quality and dissatisfaction of the customers. Long time wasted in transport phase should be avoided just because this is a non-value activity, apart from the case in which customer has paid for a delivery service, long distances negatively affect communications and increase probability to break the product thus the final quality if it. Unfitted processes could derivate from a bad investment in resources, big and expensive machines only partly exploited could lead to a utilization waste, they are not appropriate in terms of quality and flexibility. Small is good, letting short set up times, less maintenance and more adapting attitude to change with technology. Spare parts, including raw material, work in process and finished products, must be monitored because they represent a cost for the firm, an item detained during the flow of production is a non-sell item, useful for variation of the demand but passible to obsolescence. Detaining spare parts lets the firm to get discount from suppliers, for this reason is advisable to make a trade-off in supplying. Last but not least, there is "defects waste" type, it leads to reworks which do not add value to the customer, it could be intended as: selling one product at its price producing (At least) twice at a double firm price due to rework. Those factors compose a unique set which is called "7 Waste of Ohno". Summarizing, these wastes are: Overproduction, Transport, Motion, Defects, Over-processing, Inventory and Waiting (Bicheno & Staudacher, 2009). Overproduction leads to a big lead time and, in general, should be avoided in order to do not process items which are not immediately required, the goal should be to produce exactly what is requested, no less no more. The Transport directly impacts the lead time, each minute used for transportation is a delay for the customer. Often it is necessary to devote a period time to transport but if the plant, for instance, is very close to the stores in which the products are sold the customers receive them in a faster time. In addition, the probability of product damage increases with the number of transport operations. The Motion waste is similar to the Transport one, all the time wasted in operator movement directly impact the delay of the delivery, furthermore the quality of the item scaled down due to the huge effort, such as protracting, stretching out and moving, that the operator has to do. Defects are clearly one of the major wastes because it forces the firm to do further reworks which add no value to the customer, just increase the time of the delivery and the waste of resources. Over-processing simply means using resources that are not appropriated to the work to be accomplished. The use of oversized machines, for instance, results in wasting resources and not appropriate for production, affecting also the quality of the process. The Inventory is a crucial point, it must be monitored and kept at a low possible level, respecting the safety one, because it is a big source of cost for the firm. The obsolescence risk of detaining final products or materials should be considered. Finally, Waiting is related to the Transport, Motion and Defect, it increases the time delivering product and, the speed of the product delivery is now a crucial point for the competitive advantage.

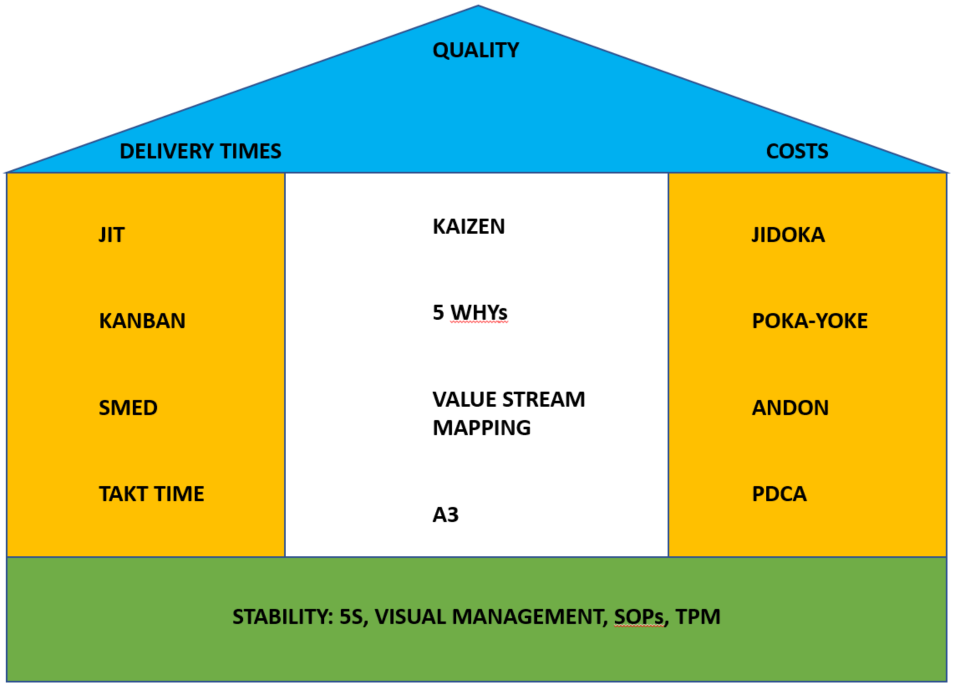
Taiichi Ohno said that the management begin on the work place. This statement could be intended as "Gemba". Gemba means going directly to the work place, in the line where the operators work, to observe the real process and get ideas for problem solving, and not doing it closed in the office (Ohno, 1988). This philosophy embraces a Lean type of management in which the managers exactly know the real situation not through reports concerning the problem of someone else, this practice encourages employees through a shared problem solving which is considered somehow as unique team composed by managers and operators working together for the same purpose.

Keeping in mind that the Lean organization focuses on the definition of "Value" beyond elimination of waste, it can be tried to define. All activities which do not contribute to create value for the customer are wastes. Economically speaking, Porter affirms that the value is the total number of buyers may be willing to pay for the product, higher the willingness of the customer to pay for it, higher revenues for the firm. That is value (Porter, 1985). From a properly Lean point of view the definition of value must be adjusted because the value is not an absolute and objective word, the consideration of value by one person could be dynamic, it could change in relation to several factors which partly rely on human behaviors that many times are unpredictable. The Value Added (VA) process step has a direct impact on the product or service and the most important aspect is that the customer is willing to pay for it. For instance, in the powder cosmetics industry, the pressing process of the powder is a required step which adds value to the customer ensuring quality of the product. VAs have to be maximized. The Non-Value Added (NVA) activity is considered not essential to produce and deliver the product or service to meet needs and requirements of the customer, him is not willing to pay for it. An example could be all bureaucratic steps inside the firm. NVAs have to be eliminated. Finally, Value Enabling (VE) represents a non-fundamental step that the customer will not pay for it, however, this activity "enable" the VA tasks to be done better. VEs have to be minimized. An example is the way of materials motion for storing and delivering, it is a necessary activity which enables the movement of the material, but it could be conducted in several ways, some of them could rise delay for which the customer is not willing to pay (Bicheno & Staudacher, 2009).

1.1.4 The House of Lean

It is useful for the analysis having in mind the pillars and the main features of the Lean approach. Here it will be illustrated the House of Lean, initially developed by Toyota, a summary of the actions should be made for integrating Lean manufacturing philosophy in the proper firm. The good new is that the House of Lean is easily to understand but, on the contrary, it refers to the necessity of building starting from the foundations, a situation which is often impractical in the firm. Not by chance, the Hose of Lean gets the basis and builds the pillars of the Lean, only after having carried out these fundamentals a firm can start to develop and apply all other tools that it will be seen in the next paragraph (Paragraph 1.2). The main pillars of the House are the Just In Time (JIT) and Jidoka which sound like "run" and "stop", it is a regulation mechanism, both are necessary (Bicheno & Staudacher, 2009). It will be seen in the next chapter the concept of JIT, instead, for defining Jidoka it could be useful to cite the words, used in Toyota Production System (TPS), of the founder of Toyota: Sakichi Toyoda. He defines Jidoka as the "Automation with a human touch" [17]. It refers to the invention of the founder namely automatic loom, that is a machine that spins thread for cloth and weaves textiles automatically. Toyoda developed a lot of revolutionary inventions into his looms, one of that was the weft-breakage automatic stopping device which automatically stops the loom every time a thread breakage is detected [17]. These inventions get more automation and let the operators more available to work in parallel. The roof of the House of Lean comprehends Quality, Time and Cost, they are the variables which must be monitored and optimized for the foresight of the firm and long run sustainability of the business. The concept of Poka-Yoke is referred to "Zero defects", its aim is to reduce defects in the production activities through devices which essentially discard the product (After it could be reintroduced in the line) each time it results non-conforming. Poka-Yoke is a technique for avoiding simple human mistakes. The philosophy of Poka-Yoke resides on the belief that is not acceptable to produce even only one defective piece. A reject level of 0,1% means that one customer over one thousand will get a defective product but for him the product will be 100% defective [3]. All other components / tools of the House will be more deeply explained in the next chapter. In figure 1.2 there is an example of House of Quality (Although there are a lot of them).

Figure 1.2. *House of Lean* (Adapted from Rafele, 2017)



1.2 Lean Concepts and Tools

Here is going to be introduced the fundamental pillars of the Lean and the tools which are incorporated in the philosophy and necessary for ensuring the right development of the Lean Manufacturing.

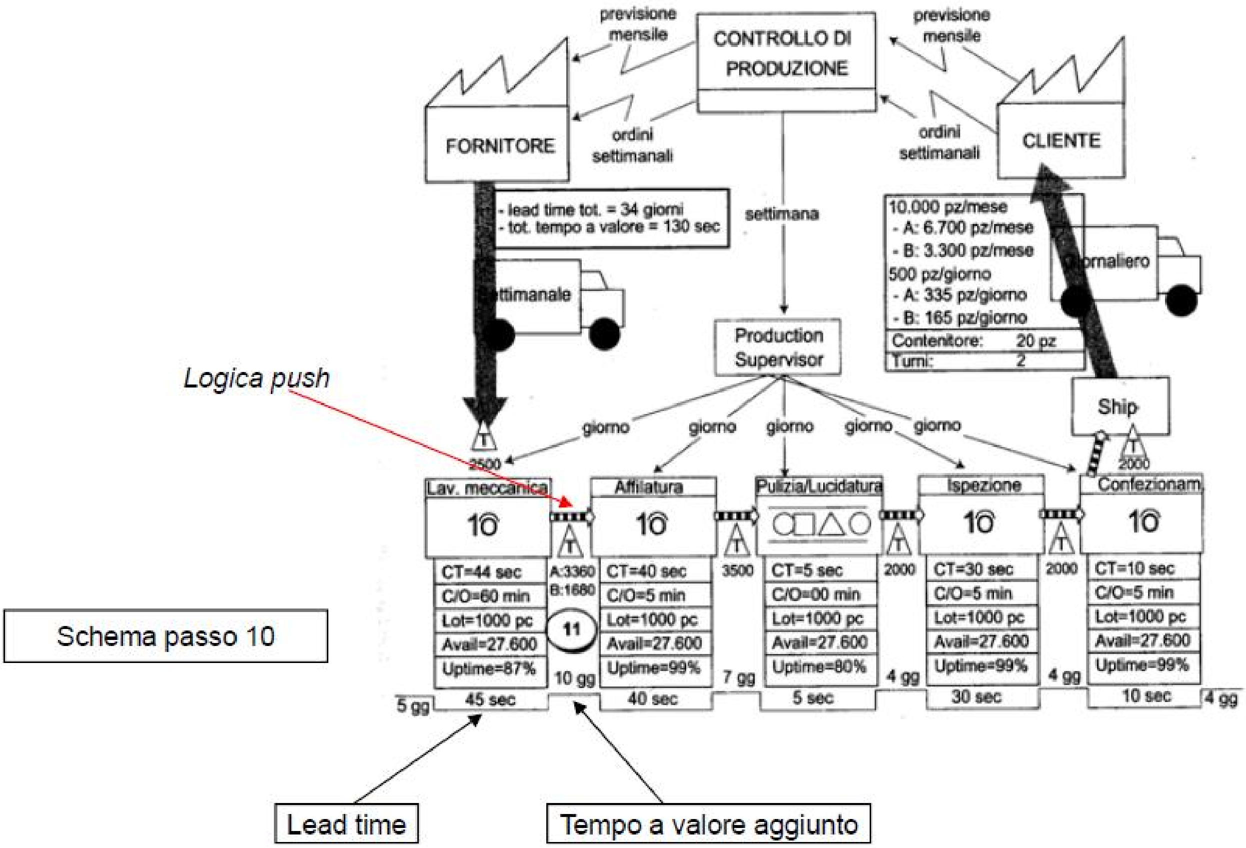
1.2.1 Fundamentals

The "Pull" concept is strictly related to the Lean Manufacturing. In a pulling manufacturing system, a work is done in response to a signal from the customer (Downstream) and the products or components are pulled from downstream to upstream within the flow inversely ran. Each cell / station (Activity) of production system asks for materials from the previous one (To upstream) every time these are consumed, often with the "Kanban" tool, which is a physical or digitalized paper containing the instructions needed. This process effectively sent a signal to the previous station to recharge material, indeed each work station has to have a buffer level for components under which the signal is sent. The production and delivery are affected by "Just In Time" (JIT), that means only if and when the customer requires the product or service and only in the quantity the customer needs. This mechanism lets the firm to balance the whole process, avoiding large buffer tails and overproduction (Shingo, 1989). Unfortunately, on the firm is going to analyze (Cosmetics industry), the pull system is less effective inasmuch it is impossible to catch in a reasonable lead time the customer demand which does not ask for constrained customization, instead the focus shifts to large production volume which ensures the right delivery to the customer. The high variability and the uncertainty of the demand lead to shift the focus of the text on the reduction of the lead time by other operational improvements, in particularly on set up times reduction through the SMED. Lean Manufacturing is composed of several instruments aim to plan, implement, improve and maintain this value paradigm. These instruments must be used in conjunction, or better, they must be implemented step by step following the natural order of doing that. Just for give an example, doing 5S (Which will be explained in paragraph 1.2.3) without concentrating first on needs of the customers will results in the non-effectiveness on applying Lean paradigm, the result will be inconsistent and wrong with respect to its principles.

1.2.2 Value Stream Map

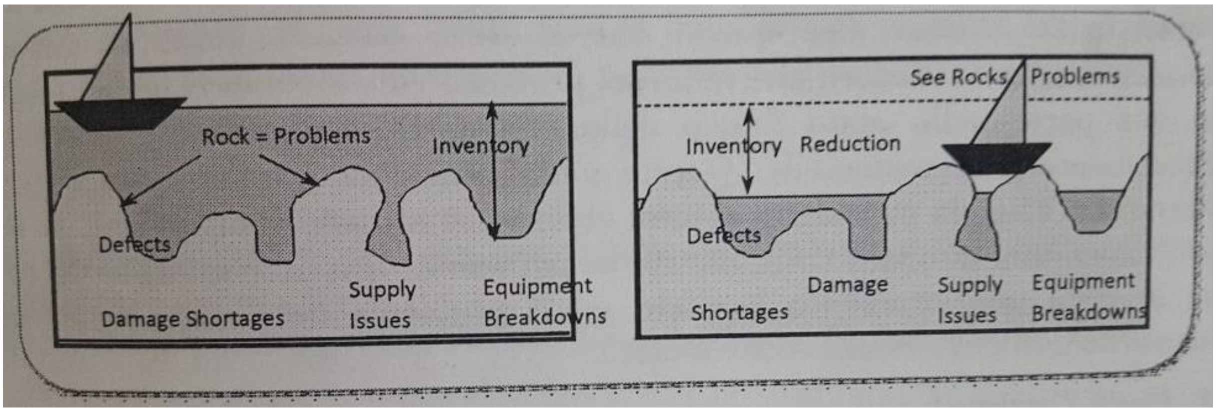
The value stream map is a tool required for mapping the actual value flow and defining the future state map, an improved process of it, about the supply chain processes. Its aim is achieved through the focusing on progressive generation of value for the client. The steps comprehend, above all, the individuation of the main actors (Stakeholders) and resources, the calculation of the monthly requests then the daily production. After that, the firm should recognize the frequencies of the supply and the delivery, map the information flow and individuate the buffers in which items are stored. Finally, it should connect the processes, marking them with proper characteristics (Indicating cycle time, available time, lot sizing, etc.) and calculate the time line comparing it with the takt time (Figure 1.3) (Rafele, 2017). The analysis includes all process steps (VA-NVA-VE) which together are essential to transport, physically and informatically, a product or service from the supplier to the customer. In practice, analyzing the value stream consist of trying to figure out the whole process, from the beginning to the end, which are required to deliver the products to the final customer.

Figure 1.3. *Value Stream Map* (Rafele, 2017)



The Value Stream Analysis lets the firm to exactly know where it works on which type of activities, value added and not, to separate one each other in order to eliminate those ones that are not required, to simplify other ones and to allocate the best resources to the valuable activities, in a few words, to eliminate wastes along the value chain and to identify the real value for the customer. Analyzing the process with the stakeholders of the firm, such as suppliers, departments involved and customers, and their functions, mapping the material and information flow then collecting times to see how long a specific or entire process lasts. This is the way to implement a Value Stream Analysis. There exist several types of Value Analysis among which Product Flow Analysis, Employee Flow Analysis, Information Flow Analysis and so on. The advantage of this type of analysis is that the firm can simplify the processes, eliminate wastes, standardize and improve productivity beyond that distributes the workload and recognizing best practice. First, it starts in analyzing the capacity of the firm, it means understanding fluctuation in the demand and how it affects the capacity. It must be identified bottlenecks activities in particular if they share resources with others process flows because they are the critical point of the whole process. Setting priority on the basis of them could lead to think about development of some products instead of other ones which could be downsized or even neglected. The goal is to reduce the lead time through the avoidance of resource accumulation in buffers (Which however is necessary and advisable on some steps) and trying to let the flow (Material, information, etc.) as constant as possible. Spare parts cover problems, they are needed to face internal variability (Defects), external one (Fluctuation in demand), unbalanced works and unpredictable set up times. Considering the analogy of "The Boat and the Rocks" (Figure 1.4) (Bicheno & Staudacher, 2009), it can be matched the rocks with problems which reside under the sea which, in turn, represents the inventory level. Maintaining it a high level, the problems cannot emerge, instead decreasing it the problems (i.e. defects, shortages, supply issues and so on) emerge and the boat quickly gets stuck. The Lean method is aimed to gradually decrease inventory letting problems to emerge, one at a time, to solve it and carry on to the next one. In this way the stock reduction becomes a tool to identify issues, but it has not to be indefinitely reduced.

Figure 1.4. *The Boat and the Rocks Analogy* (Bicheno & Staudacher, 2009)



To complete the discussion about the flow, it must be clear that is the demand the main actor of the case, it is a crucial starting point for the analysis and it could be manipulated a bit despite of it is crucially imposed by the market. A firm might control the external demand through avoiding discount quantity policy, which increases the stock detained, in favor of constant and regular orders policy with suppliers, adding variation elements until last possible time, sharing the Lean policy among all departments involved in the value chain, from suppliers to deliverers. Instead, from the internal demand point of view a firm might reduce variability and uncertainty through the integration of buffers if necessary or reduce set up times in order to decrease the lead time. Flexibility means frequent and small lots, giving priority to regular orders and avoiding overproduction which could became a trap for the firm.

1.2.3 Five Standards and 5 Whys

Five Standards, also called 5S, could be intended as a process to clean up the work environment in a wide sense, aiming to reduce wastes, variability and increase production. The five standards are in order: Sort, Simplify, Scan, Standardize and Sustain (Respectively Seiri, Seiton, Seiso, Seijetsu and Shitsuke) (Hirano, 1995). The first action is to sort the production area and to cluster working elements by needs and utilization. They are monitored for a while and after a period of observation same tools will result unavoidable for the operator while others will become useless. The only needed objects that are necessary for the execution of the respective work step should be detained. To simplify implies to mark the essential objects in a way that they can be assigned to certain positions and everyone can find them at the right place and return them to the right place at a reasonable motion time. Scanning means to remove the dirt and dust from the work environment, which allows easier detection of damages and deviations. This step is fundamental to point out disorder and to generate questions about the reasons of it (Bicheno & Staudacher, 2009). Some firm implements 5 minutes routine which is a periodic control and verification of the line and the operator to see if the tasks assigned to it are accomplished or not. Only by now a firm is ready to adopt standard procedure which is intended as a continuous process to "Sort", "Simplify" and "Scan" and shall be applied daily or weekly to monitor the situation minimizing or eliminating those activities which are undesirable. At the end "Sustain" has to be the glue of the previous ones and the factor which lets the firm to carry on this program in time, the aim is to secure the effectiveness of the observance of "Sort", "Simplify", "Scan" and "Standardize". What makes "Sustain" successful is the involvement of everybody (From operators to the management), the integration of the 5S in daily work, the communication of duties and roles to everyone.

If someone asks to International Organization for Standardization (ISO) what standard is, they answer as follow: "International Standards make things work. They give world-class specifications for products, services and systems, to ensure quality, safety and efficiency. They are instrumental in facilitating international trade" [4]. In a general sense, a standard is something which adds value to the product, system or service because, respecting quality and safety, it is just used by everyone. The best standard should be better and clearer with respect the others, the one which suggests that doing the same activity or action in another way would just results unadvisable. "The standardization work is the philosophy, the Standard Operation Procedure (SOP) is the mechanism to get in practice" (Bicheno & Staudacher, 2009). The SOP is an established procedure which has been sown to work well and then institutionalized in the firm. Once a procedure fails, analysis and reports are developed, another process replaces the previous one in standardized work letting the operators to work in an easy way. Ohno believes that the operators must get directly involved in SOP procedures because they have to know the problem and how to solve, it regards their job and must participate actively on projects getting their help (Ohno, 1988). A standard should be dynamic, or better, not static (As not the word implies), as it said before (Bicheno & Staudacher, 2009). From Standard and Davis point of view the standard work owns three key concepts, the first is that standard work is not static and when a better procedure is founded this replaces the previous one; second is that standard work supports stability and reduces variability because the activity is performed each time on the same manner, furthermore, variations, as defects, deviations and discrepancy, are easily recognized; eventually the standard work is essential for the continuous improvement, moving from a standard to a better one without going back (Standard & Davies, 1999).

The 5 Whys is a technique aims to explore and ensure the root causes of a problem, it consists in asking to someone or to ourselves 5 times why an issue is present, going deeply in the solution. To notice that the number of times is not mandatory. An example could be this one: the door seems to be not closed as it should be. Why? Because the hinges are usually not positioned as they should. Why? Because, even though the robot which arrange the hinges is robust, the frame over which the robot is fixed does not always place exactly in the same place. Why? Because the overall framework which contains the frame is not rigid enough. Why?

Because it seems that the rigidity of the framework was not deeply considered during production. So, the real solution will be the rework of the structure design for the production (Bicheno & Staudacher, 2009).

1.2.4 Visual Management and One Point Lesson

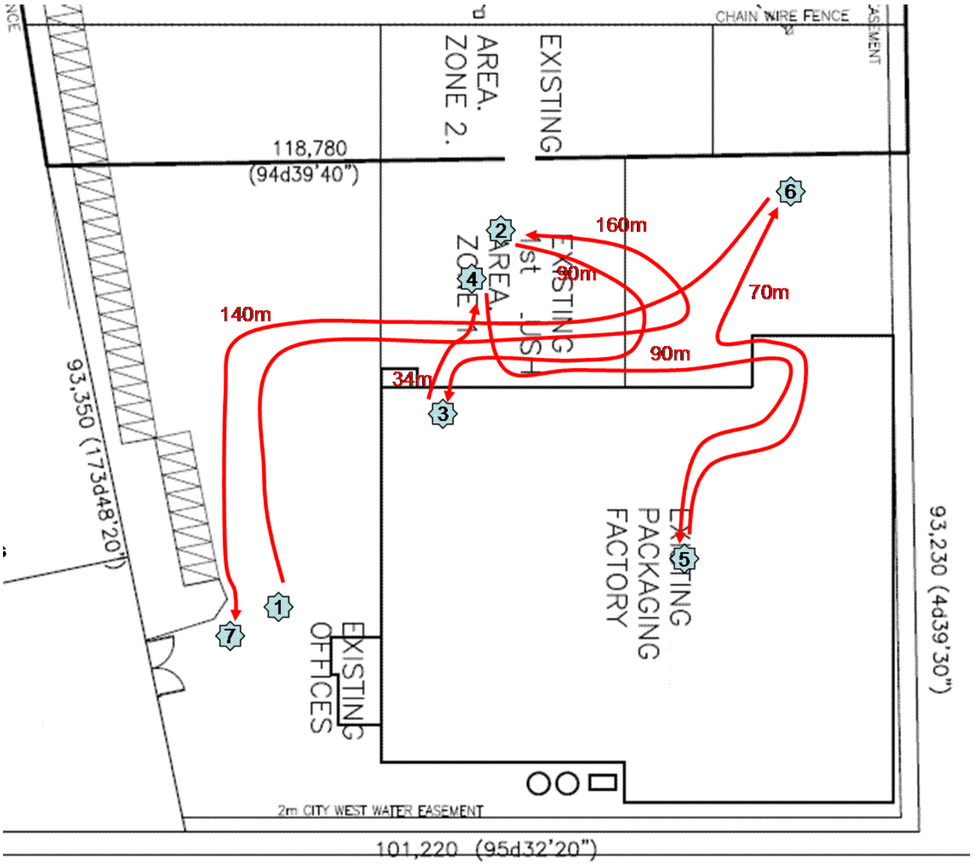
The Visual Management is a sort of extension of the previous concept and, of course, they could be applied in conjunction. Visual Management consists in the continuous involvement of everyone in participating on daily work routine. It uses, above all, a panel in which the operator can find all information that he needs, such as the state of the line, data about the product he works, materials, standard times for each activity and daily scheduling. In general, the tools belonging to the Visual Management technique are characterized by an immediate visualization by everyone of everything that should be monitored or standardized. A typical example are the lights in the line which indicate to the operator if the machine is working right or not (Bicheno & Staudacher, 2009).

An easy tool is the One Point Lesson (OPL) which consists in a sheet located in the engaged area that can be read in a few seconds which clearly explains one single issue that has to be improved using pictures and not many words, it must definitely be clear by everyone (Bicheno & Staudacher, 2009). In the firm is going to be introduced in the Chapter 2 there is a several uses of OPLs, within the production unit, especially over the machines or very close to them. Someone can easily find little laminated sheets which are used to not repeat a mistake occurred in the past, to propose a single improvement or to deny forever something wrong already faced and solved. The use of OPLs keeps a simple right procedure trying to standardize it along time, after a while, indeed, it will be removed because it will be incorporated as knowledge by the operators and technical support staff, which is the technical internal employed team that restores the lines when a breakage or an issue occurs, a single person belonging to this team would be also called mechanic.

1.2.5 Spaghetti Chart

The Spaghetti Diagram (Chart) is a useful tool which helps in visualizing transportation and motion wastes within the production unit or wherever. Notice that the chart could be also used in other functions and areas of the firm. The chart is created by drawing the physical flow of the material or product on the plant layout figure to see how it moves among different resources before delivering to the customer or leaving the plant. It is necessary to draw all resources involved, the entire distance covered by the motion of the product and try to figure out the motion waste. It should be marked at least two flows, one is the observed product flow and the other the regular and scheduled product flow in order to see how and how much the two flows differ. Thus, the Spaghetti Chart is the main tool for the determination of the best path (Bicheno & Staudacher, 2009). Below there is an example of Spaghetti Chart [18] over which the product motions are drawn related to their distance figuring out how much the product shifts along the plant (Figure 1.5).

Figure 1.5. *Spaghetti Chart* [18]



1.2.6 The Philosophy of Kaizen

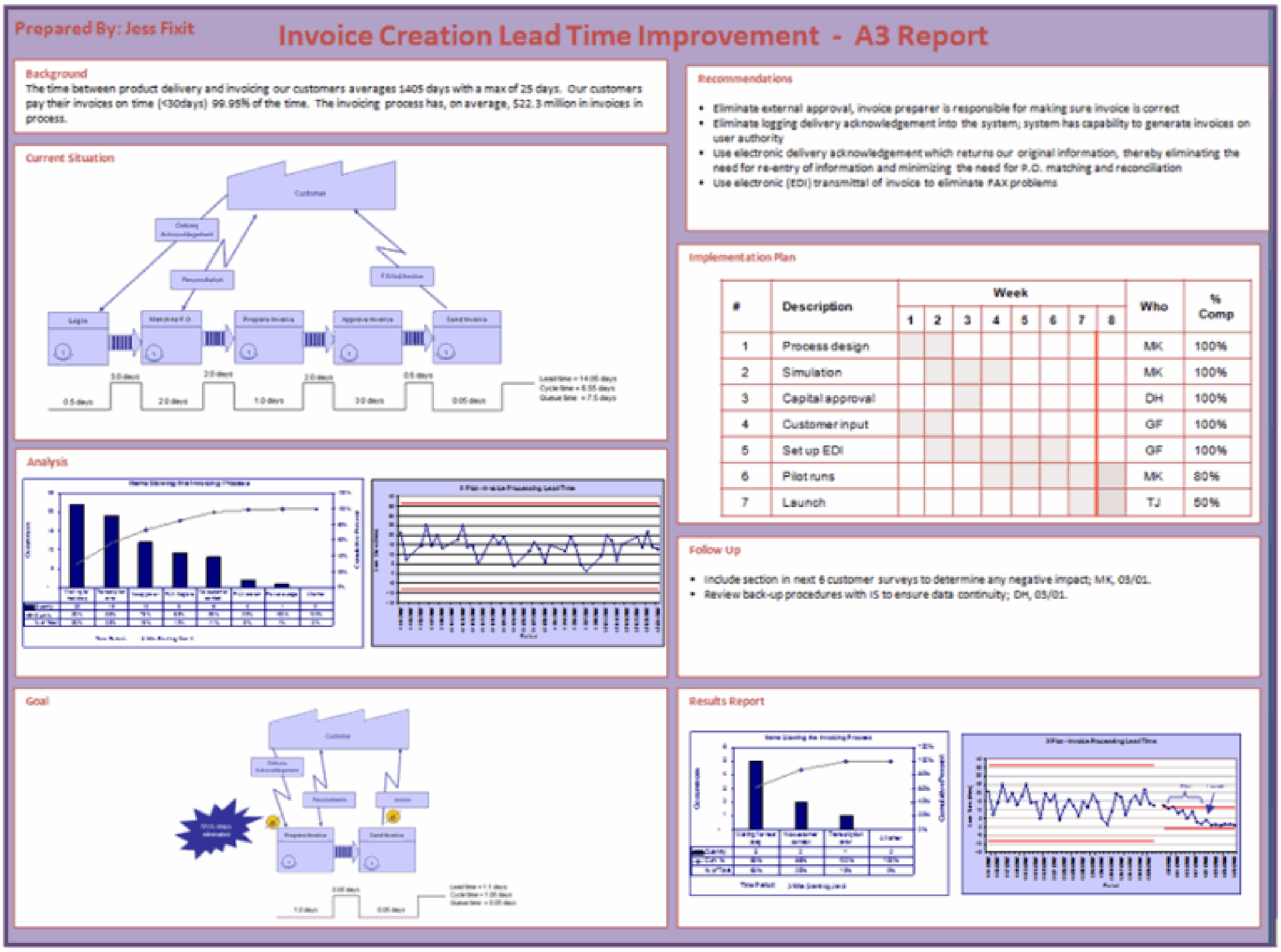
Let's introduce the essential concept of Kaizen. It is the Japanese word for indicating continuous improvement in each direction. Make a Kaizen means to search for continually improvements defining aims to solve specific problems, to eliminate tasks, decrease time or change some activities. This activity must be monitored and stored in a database indicating key words, a description of it, the stakeholders involved, the area in which the event occurs and time period. The important initial setting of events like this is to indicate the responsible of the action and the time in which it should be done. Those factors clearly became indicators of the plan and get the possibility to monitor the situation in time. The best practice is to involve all stakeholders affected by the Kaizen, from the operator to the supervisor, for the best implementing solution. The strength lies in the fact that after the solution implemented, there is no possibility to fall in it again because everyone knows how the issue was solved (Bicheno & Staudacher, 2009). The imperative is not to fall in the standardization trap in which once it is made, the process is right validated and no more actions will be made, there will be a necessary and continuously improvement because the production (The firm, in general terms) follows the customers and they are characterized by a deep uncertainty, thus the standardization of the processes must follow this paradigm and then has to continuously change, by means not to standardize. It could appear as a contradiction, but in realty the steps are finding a solution, verifying if it is an optimal local solution, standardizing and as soon as some factor changes, repeating again the steps in order to adapt the new best (Standardized) solution again.

1.2.7 PDCA and A3 Method

The cycle Plan, Do, Check, Act (PDCA) represents the most used improvement cycle aimed to analyze difficulties inside the firm. When an issue is come upon the first phase is to plan an advisable program to deal with it. To Plan means scheduling, devising communication, organization, goals and time window. Every objective and constraints must be fixed in order to give a widely and clearer idea of the problem. The Do is the phase in which a firm should actuate the program to eliminate or reduce the issue. During this phase the implementation of the solutions has to be made. The next step is Check which is characterized by the presence of some indicators, they are the only objective things which might help in monitoring the solution implementation. If we ask ourselves if the plan was good implemented, the answer will get from the Check phase through the indicators. Last, but not least, the phase of Act is needed to maintain the improvement made on PDCA cycle, a firm needs to maintain what it got (Bicheno & Staudacher, 2009). Standardization is the key to maintain the effective advantages got from the action made in order to apply this practice to a future similar problem and gaining experience and competencies. It needs to involve every stakeholder affected by the problem just thinking that everybody can get his contribute to solve it. Let is imagine a team which does not effectively communicate, then the quality of the solution would be poor.

The concept of A3 refers to the size of the sheet (Figure 1.6) [19] used for illustrating the PDCA plan, it is a problem solving standardized methodology which helps in visualizing the entire process. Through the uses of this format is avoided a more pages report, it forces the synthesis and it is simple. On the left of the sheet it is written the current state of the process instead on the right the future state (i.e. the implementation of the solution). To notice that the left size contains the Check and the Plan steps, the right size regards Do, Act and again Check phases (Jimmerson, 2007).

Figure 1.6. *A3 Sheet* [19]



1.2.8 Total Productive Maintenance (TPM)

The thesis is approaching to the core theme of the text, doing that, there is the need to introduce an important concept which is strictly related to the next sub-paragraph that speak about SMED. This concept is the Total Productive Maintenance (TPM). It minimizes machine break downs, extends the life cycle of it and ensures the stability of the production process which relies on the integrity and reliability of them. TPM combines preventive maintenance with the goal of total quality which, now, should be declared.

They are (Bicheno & Staudacher, 2009):

- Involvement of all participating employees (Engineers, operators, maintenance personnel, cleaning staff)
- Zero defects
- Zero machine breakdowns

- Elimination of the "Six Major Losses" of equipment effectiveness (Equipment failure, reduced production rate, process defects, changeovers and adjustments, reduced yield, idling and stoppages)

A basic requirement for Total Productive Maintenance is the periodic execution of 5S which should not be underestimated. The most important index for the TPM is Overall Equipment Effectiveness (OEE). It shows how many percent of the scheduled operating time of a machine is effectively used (For production). It is an extremely important indicator for production which is used for comparing efficiency among the lines and to identify critical resources of the process which must be monitored. Note down that a general machine must be considered not entirely available for evaluation of the plant / case. The OEE index is related to the Six Big Losses of a machine which are divided in the categories showed in the formula above. This index represents the "good run" of the line which produces in cadence without defects, so it produces good pieces available to sell. It is obvious that the higher OEE the better for the firm because it can produce the best output.

$OEE = Availability \times Performance \times Quality$

In which (Willmott, 1994):

- *Availability* is the proportion of the scheduled production time that the equipment is available for use (Takes unscheduled downtime into account). It includes breakdowns and setup loss times.
- *Performance* is the actual production rate as a proportion of the ideal production rate (It considers the slowing of the line or other inefficiencies while the line is running). It includes micro-stops of the machine and under cadence running.
- *Quality* is the proportion of good units that are being produced (i.e. the yield of the production line). It includes defects (Which cannot be sold) and losses in the initial temporary (Trial run) after the setup time.

An example is showed below:

Let us consider the available working time to be 8 net hours, the cycle standard time of the machine is 1 minute instead the breakdowns are accounted for 30 minutes, the setup times are 40 minutes. At the end of the working time the line will produce 350 finished products, 50 of them are defects.

So that (Bicheno & Staudacher, 2009):

Availability: (Available Time – Breakdowns - Setup Times) / Available Time =

= ((8 x 60) – 30 - 40) / (8 x 60) = 410 / 480 = 85%

Performance: Number of Finished Products / (Available Time – Breakdowns - Setup Times) =

= 350 / 410 = 85%

Quality: Number of Good Finished Products / Number of Finished Products =

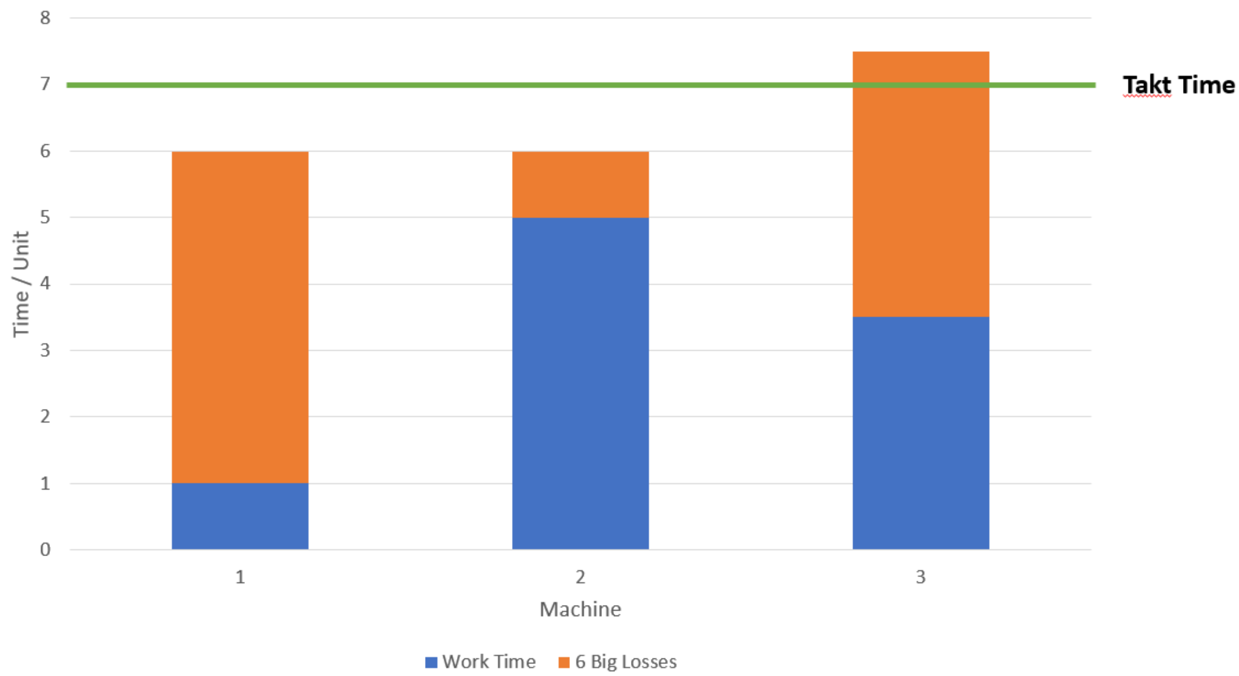
= (350 - 50) / 350 = 86%

OEE = Availability x Performance x Quality =

= 85% x 85% x 86% = 62%

It is important to manage this indicator because it is not really true that the line with the highest OEE will result the best. The critical point is not to use the indicator alone but in conjunction with other data. It could be considered a performance diagram (Figure 1.7) of three lines showing the time per unit functions of time. Drawing the takt time line in the diagram it could be seen that the first machine does not exceed it but due to the Six Big Losses, it works definitively less with respect to the third line which exceeds the takt time line but works effectively more. The second machine is characterized by the highest working time and the lowest lost time. The possible mistake could arise in focusing on the first line instead of the third one because it works less. Focusing on machine cycle had result not relevant until the total time remains below the takt time (Bicheno & Staudacher, 2009). Concentrate the efforts on the Six Big Losses of the third machine to reduce the time of it, this is a sort of bottleneck line which unbalances the entire production increasing the lead time.

Figure 1.7. *Working Time Example* (Adapted from Bicheno & Staudacher, 2009)



Finally, it is better to design and own machines for an easier handling, changeover and maintenance and for responding quickly to the change of technology. Most of all machine defects are due to two major reasons which are insufficient lubrification and contamination. Regular trainings of operators who work in the line in handling and maintenance must be done for better preventing issue beyond that a designing of a preventive maintenance plan which cover the entire life cycle of the machine. It is important to notice that in a firm not all components or spare parts, products or people are equals, each one owns a proper value. For this reason, Pareto suggests a simple and intuitive analysis in which, for instance, are listed all spare parts needed for production, it is created a diagram in which there is the value in one axis, SKU in the other one, where SKU represents the number of parts kept of the component. It can be seen that the more a part is valuable the less will be the detained number of it because it is more costly (These items should have dedicated structures in order to control them), instead the parts affected by small intrinsic value can be stored as more large volume (Giving less attention to them, these can be shared with other non-valuable parts in the cell). Doing this, means applying the (ABC) Pareto analysis in order to let is concentrate the efforts in a proper manner or, to say it in a different way, to give more attention and resources on what is really important for the production (Bicheno & Staudacher, 2009).

1.2.9 Single Minute Exchange of Die (SMED)

Here, it is going to be introduced the pillar of the analysis which, in conjunction with other tools already exposed, has huge practical implications on operational works of production. Single Minute Exchange of Die (SMED) aims at a reduction of changeover times (Setup) among production processes. The setup time is the one elapsed between producing the last good part of the first lot and the time of producing the first good item of the next lot (Chen, 2009) (Eren & Guner, 2006) (Liu & Chang, 2000). The father of SMED was Shigeo Shingo which suggested smart improvements on changeover activities through the simplification of the streamline and the execution, as much as possible, of the activities which could be done while the equipment is running (Shingo, 1985). The setup is required for switching the production of the products (Format of the products) and it is essential to do it in the lowest time because, as its said, this is considered wasted time. To notice that the format is the variable structure that a line can fit in relation to different products. The type of the interchangeable parts and the combination of them together define a set which results in a specific format of the line. For instance, a line could be shaped by different formats which in turn can process different products (One format, many products). The changeover activity is not strictly wasted time because its needed to preparing the line for another type of work but, remembering that it is a NVA activity, it must be monitored, controlled and minimized enhancing more time to effective production. All the activities performed during the changeover can be clustered in two groups: internal activities which must be done while the machine is off so that these have to be minimized, and external activities which can be accomplished while the machine is running. Modifying the equipment seems to be the most effective way to face the reduction of changeover times (Shingo, 1989). It is recognized that the effective implementation of Lean criteria, like JIT, Kanban and Pull systems, requires the use of small batch sizes (Gadre, Cudney, & Corns, 2011) which can be achieved by effectively reducing setup time. The need for setup time reduction has become increasingly important in production lines with a wide variety of products (Kumar & Abuthakeer, 2012). In this cosmetic firm case, as its said, applying a real JIT deploying an effective pull system is really difficult to implement, despite of all the use of SMED technique is needed in every case to reduce setup times.

As Shingo proposed, there are four steps to conduct the SMED analysis:

1. Separate internal from external activities.
2. Convert internal to external activities.
3. Optimize and reduce internal and external work (Above all the internal ones).
4. To standardize.

It follows that it has to be listed all activities involved, marking them as internal or external ones and cluster them into macro groups of setup operations, which could be:

- Supply of materials and tools, preparation of the work (Typically it is an external activity).
- Removal, cleaning or installing components of the machine (Typically it is an internal activity).
- Centering and adjustment machines.
- Starting and trial runs until first good output.

Shingo has acknowledged that adjustments and trials account up to 50% of changeover time and then most of the efforts must be devoted for reducing them, saying more, him also affirms that, in some circumstances, two people working on the line in parallel might reduce the changeover time more than 50% (Shingo, 1985). Many smart ideas might help a firm in reducing setup time by considering, in relation to the features of the firm, several little adjustments in each phase of the SMED. Remembering that in most cases modifications are easier and often less expensive when they regard the product, the various interfaces or the tools, instead many issues might arise when modifications have to be adopted in the line body elements (Braglia, Frosolini, & Gallo, 2016). Converting internal works into external ones may be accomplished through a change in the organization, a better layout structure can be set optimizing the proximity among lines and warehouses, special technical tools might help operators in faster removing and installing parts, machines can be monitored according to TPM principles in order to decrease failures and then adjustment and trial runs. These are some examples of reducing changeover times by simply using brain and logic applying them to the peculiar case. Setup time strongly affects OEE line indicator, thus it could be a nice starting point to improve the performance of the machine. Note down this equation:

Setup time x Number of batches = Constant

It shows that a decreasing in setup time should lead to creating more batches of less product dimension each (Bicheno & Staudacher, 2009). Do not fall in the trap of not diminishing lots just to gain extra-capacity. Doing more batches, having reached a minor setup time, allows flexibility in the production, i.e. the ability to make mixed products several times shaping the customer demand unlocking a proper Pull system in the light of JIT. In the case study will follow (Chapters 3 and 4), it will be seen that standardization is the best practice to implement after having reached a lower setup time as many operators use their own methods to do the same job increasing variance in the process. Were standard procedures to be in use, including standardizing any improvements done, such variability of operator practice would be less likely (Lee, 1986). Clearly, it is important to standardize what it is gained and to apply procedures each time on the same way. That is learning ability which leads to the maintaining of the best practices. Particular attention must be paid to the inventory size in relation to the SMED procedures. Holding an inventory (Often needed) leads to a cost proportioned to the size of it, the practice of purchasing many spare parts and the overproduction directly and negatively affect the inventory cost, they increase the number of items held, by materials or finished products, keeping busy space and forcing the firm to spend more for the management of them. It is necessary to make a list of all necessary tools needed for the job, from the production itself to changeovers, non-necessary ones must be discarded or rearranged in order to keep the warehouse lean as more as possible, then the inventory size must be minimized only detaining the tools needed (Or finished products as covering fluctuation in demand).

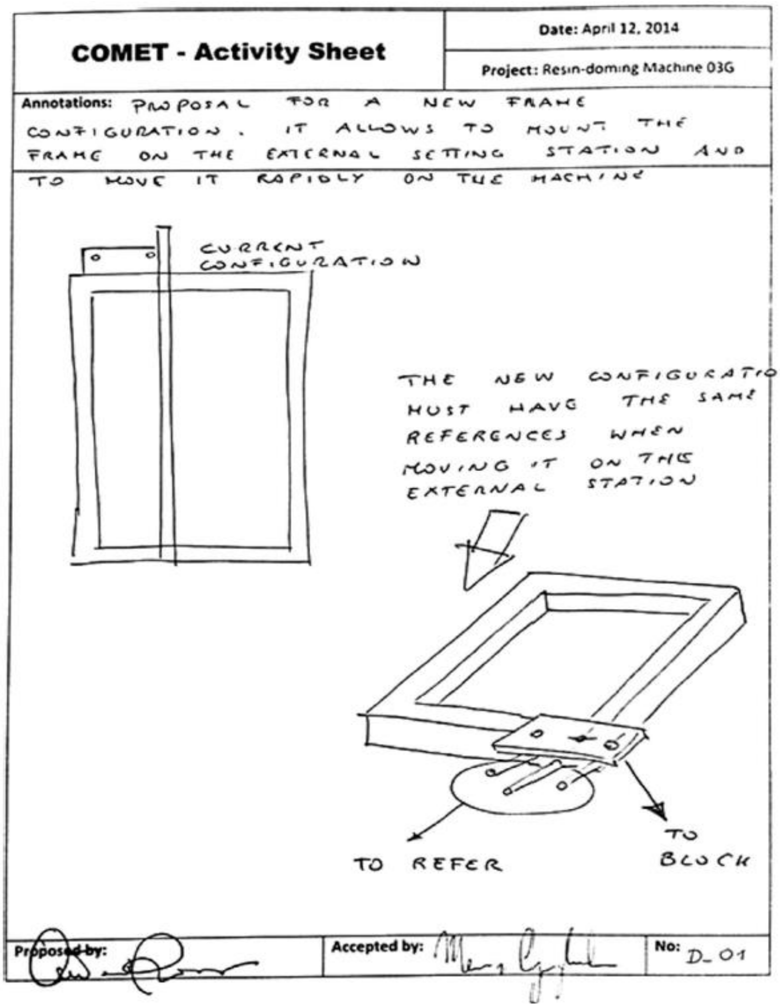
Inventory size = Cycle stock + Buffer stock + Safety stock

In which cycle stock is the average demand per period times the average lead time of production (That is the time needed by a firm to make the production), buffer stock is calculated as two times the standard deviations of the average demand for determining the buffer within lines which avoid tails. Finally, safety stock is directly affected by scraps or defects, the more are defects during production (Alternatively, the less is the quality) the more safety stock increases, indeed it is calculated as average scrap per period time plus two standard deviations from the average number of defects (Bicheno & Staudacher, 2009). Giving an example, it might be considered an average lead time of 8 days, an average demand per month for 200.000 units, the standard deviation of it is 10.000 units; the average defects per month are 15% of the demand then 30.000 and its standard deviation accounts for 20% of it, so 6.000 units. In turn the inventory size will be:

Inventory size = (200.000 x 8) + (10.000 x 2) + (30.000 + 6.000 x 2) = 1.662.000 units

In order to conclude this paragraph, it must be noticed that the SMED system is based on two principles: technical change to dies and presses and organizational changes to the labor processes involved in die changing. To be precisely, the distinction has to be made between design changes which includes all the actions that strongly modify the environment of the firm such as layout structure or types of machines. The principal aim of the design is to deploy fitness among the elements inside the firm to easily let the flow regularly and smartly. Instead, organizational changes comprehend all the actions which work around the design, they do not modify the structure but indicates how the people arrange themselves in function of the design, optimizing the work. It is established a hierarchy among people and are assigned roles and responsibilities to each of them (Rawlinson & Wells, 1996). The design has more power and attributes to alter the way in which a changeover is conducted and tends to be more permanently in changing the time of it when an action of this type is done. Paying more attention to the quality of the design at the first stages could benefit the firm, instead an organizational change might be made once a design is done. For this reason, the organizational actions are less effective than design ones. In figure 1.8 (Braglia, Frosolini, & Gallo, 2016) there is an example of design change in a SMED application.

Figure 1.8. *Design Change* (Braglia, Frosolini, & Gallo, 2016)



1.3 Other Industry Lean Applications

The Lean Manufacturing method could be applied for every type of industry since it is not a specific application limited on its ground rather it is an attitude. Applying the Lean Manufacturing means thinking about lean and agility, faster developing and high flexibility. This could be done for every type of industry, job and organization always keeping in mind that, case by case, limitations, peculiarity and restrictions must be considered. The typical Lean Manufacturing system relies in the automotive sector applications in which several activities have to be accomplished for the completion of the final product and a Lean organization is needed for accelerating the process. Automotive sector is not the solely case to apply Lean concepts, of course this is the most important industry in which Lean tools have been used, so an application in this industry will be conducted in addition to other types of applications.

1.3.1 Automotive Industry

The case of Mercedes Benz really explains the essence of the Lean Manufacturing, indeed the case study showed, focuses on minimizing inventory and reducing work in process. When Daimler-Benz set up its new plant in Rastatt for the Mercedes A-Class, the Lean production was the first aim. The firm has concentrated itself in developing just in time production reaching 70% volume of components delivered through this method. It is obvious that in the automotive industry reaching these goals (Pull production and Just In Time) is easier than in the cosmetic one just because the lead time required for building a car is more tolerated by people who ask for customizations and they have willingness to wait for it, instead in cosmetic sector is preferred to make a large production volume which continuously ensures the right delivery to the customer. In the case study is mentioned how the Group exploits the advantage in having very close located suppliers in the adjacent supplier park (More than half of them are there). There is an 80 meters tunnel which links the supplier park to A-class assembly building, through an automatic transfer system which move parts in sequence directly from suppliers to the assembly line, the items run fast in the supply chain allowing a reduced lead time of production. Reducing a lot transport costs has leaded to great savings (Kochan, 1998). The higher the deliver frequency the more important is the geographical and temporal supplier proximity in order to minimize transport costs and maximize reliability (Larsson, 1999). Thanks to this system the Group has reduced the volume of transport required by 60% and the distance travelled by 6.1 million km per year. Furthermore, the number of deliveries to the suppliers on the site is only 40 per day whereas otherwise 110 would have be needed. Another aspect related to the supplier management is that all companies resided on the supplier park have guarantees a contract throughout the life of the A-Class which is likely to be about 6 years. The park is structured to allow all suppliers to expand their facilities in the case of changes in production allowing a better flexibility. All 175 A-Class suppliers have been retained as single-source suppliers as a strategy of Daimler-Benz group. The suppliers are involved from an early stage in the design of the product assuming a form of pilot project, the goal of the Group through this strategy is to freeze customer orders 10 days before the vehicle starts being built. Once customer options are fixed, suppliers and sub-suppliers can start planning their own manufacturing activities allowing to achieve a Lean production (Kochan, 1998).

Instead, the Skoda case study focuses on the deployment of Kanban system that ensure that bins of parts are replenished in the line when they are consumed. A fleet of forklift trucks patrol the hallway permanently, picking up Kanban cards and delivering items required. The Andon system is also effective in the firm, it represents a Lean Manufacturing technique which allows operators to know information and data useful for their own job. In the Skoda system, suppliers must deliver the right module to the line at the right moment, in line with the Lean principles, they usually are not subject to last minute changes in production mix. Milan Stanek, who owns an high position inside the group, said: "An automated store with a capacity for 190 cars, situated between the paint shop and the start of the final assembly line, enables the original production sequence to be maintained even if defects have been found during body shop or paint shop operations" (Kochan, 1998).

1.3.2 Sheet Metal Stamping Industry

Moving to the sheet metal stamping industry, it is noticed that, due to the global economic recession and domestic political problems, the welfare in this region has slowed since 2012. Companies, trying to keep in the market and to remain competitive, had raised the culture of the Lean through its tools. It was seen that applying Lean Manufacturing to the processes had increased value adding activities in total work by 31%, it was gained a reduction of waiting time for 58% and reduced unit production errors by 44%. Analyzing the process, it was seen that, out of several steps, those ones which took more time were deburring and polishing activities. These two process times were decreased through the implementation of the Lean tools, starting from the Process Flow Analysis to Value Stream Mapping, in order to show how and why those activities were so longer with respect to the total production time. They took 83% of the total processing time. Through cause and effect diagram the firm has noticed that the motion was the main issue of the process and thanks to 5S and Visual Management tools the firm was able to balance the work, decrease process time and motion of the operators (Choomlucksanaa, Ongsaranakorna, & Suksabaia, 2015). The implementation of Five Standards and the review of all activities are easy to conduct and usually lead to an increase in productivity and quality (Bicheno & Staudacher, 2009). In particular, the processing time was deceased by 62.5% and there was a 66.53% reduction of motion waste. The most important result relies on the cheapness of the Lean Manufacturing tools which enable huge improvements without high cost technologies and too expensive investments (Choomlucksanaa, Ongsaranakorna, & Suksabaia, 2015).

1.3.3 Textile Industry

Citing an article by Hodge, it can be analyzed the improvements made simply having applied the Lean tools in a textile firm. Also, in this case these instruments have been resulted strongly effective as in the case of Alice Manufacturing firm which began to use these tools for cutting costs and eliminating streamline processes and wastes. Understanding the importance of these techniques the firm gone ahead in using them, they, in particular, set up work cells and applied six-sigma approach for preventing quality defects resulting in the increased production and sales up by 15%. Another example was given by National Textiles that began their Lean Manufacturing implementation process in 2004. The primarily goal of the firm was to reduce waste and improve productivity then to improve throughput and flow among the processes. The results were successful since the firm obtained a 30% improvement in productivity and reached a 40% cost reduction, farther it gained a reduction in the number of unnecessary set ups by 50% and a reduction of set up time from 15 to 5 minutes [13]. In order to gain these production advantages, the firm implemented 5S tool and applied standard work for the processes required after having calculated cycle time and takt time. Other advantages, such as the reduction of raw materials detained, the reduction of inventory and the production time, were achieved. As it was seen, the use of lean tools lead to competitive advantage in many cases, no matter the type of industry, they are universal tools which could be applied on production site, but the essence of the Lean is that it is a philosophy, an attitude which can be extended to every department of the firm (Hodge, Ross, et al., 2011).

1.3.4 Hospital Industry

As it known, the Lean principles could be applied in several industries and functions inside the hospital, not only production function should be involved. This is the case of a psychiatry clinic in an Irish hospital. The project was aimed to explore the effectiveness of written communication on patient care plans between a Clozapine clinic and its various outside stakeholders. The process was characterized by some mistakes, one of that was the information flow. Patients had to be registered with the Clozapine Patient Monitoring System and only pharmacists and psychiatrists registered with the system could prescribe and dispense the medicine. For this reason, the team involved in the project used a Lean Manufacturing tool that was the Value Stream Mapping to examine and tracking the flow of the process (Laureani, Brady, & Antony, 2013). In the Analysis they used logic trees to identify root causes for the unwillingness of medical records and then they cross referenced them against effects using a cause-effect matrix (Blackstone, 2001). The screening of value-adding and non-value adding activities was conducted in order to maximize the first ones and minimize the others along the process flow. It was founded unnecessary delays in waiting until the following Clozapine clinic would have read and approved. The TO-BE analysis was conducted, the team redesigned the non-value-added activities such as printing off and correcting draft letters were removed, waiting steps were eliminated and IT infrastructure was changed to allow draft letters to be edited directly on the server of the clinic. The key success factors of the improvement were the commitment of the clinic staff and their strong willingness to implement the revised process, furthermore the support of the hospital IT team was crucial in the changes on the IT infrastructure. The lead time of the written communication process was reduced of 80% and, most important, this reduction was achieved without an increase in cost and further resources were not applied. The reduced lead time achievement leaded to a reduction in the number of queries coming into the clinic from patients and community mental health teams. This saved time was distributed along the process enabling more time to devote in value-adding activities such as more time for the psychiatrists to spend with patients and gained time for secretaries to deal with other backlogs (Laureani, Brady, & Antony, 2013).

2. L'ORÉAL

In this chapter it will be illustrated the long history of the giant Group named L'Oréal, known all over the world. After that, the focus will shift to the Settimo Torinese Plant, in which the thesis was conducted, illustrating the policy and the supply chain structure of the firm. Furthermore, several information will be provided concerning the Lean approach used in the firm as one of its most relevant strategies in order to gain competitive advantage.

2.1 The History and the Evolution of Products

Everyone knows L'Oréal brand and its history (At least the recent part), in this paragraph will be introduced the origins of the brand, its evolutions and the products which have been characterized the history of the Group.

L'Oréal is now the world leader in beauty: makeup, cosmetics, haircare and perfume. At the beginning of its history there was a young chemist which in 1909 founded in Paris the company that became early the Group, his name was Eugène Schueller. He owned strong entrepreneurial attitude and he rapidly understood that, for the development of the firm, he should have focused on research and innovation in the service of beauty. As a young chemist, before the foundation of the Group, he created his first hair dye formulae under the name of Oréal using a blend of harmless chemical compounds providing a wider range of colours which differed from other methods on the market, Schueller files for a patent (N. 383920) on 24th March 1908. Through his determination and spirit, the founder increased his success letting the world know his dyes convincing Paris hair stylists to use his products. Oréal hair dyes became famous also in Italy in 1910, in Austria one years later, in 1913 in Netherland and then worldwide from Canada to Brazil. Schueller, carrying on in innovation and research, unveiled L'Oréal d'Or a ground-breaking hair-lightening product creating golden tints and lending an ever more natural look to blond hair, successively the founder took over the company Savons Francais located in Clichy which became early the headquarter of L'Oréal, he modernized the business focusing on improving quality and planned a strong advertising campaign of the famous Monsavon brand. With the increasing of hygiene issues among people, Schueller understood the need of them in washing hair more frequently, so he launched on the market O'Cap hair lotion, a lather which could be used without water, a sort of ancient shampoo. A sort of revolution, or better a differentiation with respect to competitors relied in the packaging, indeed Schueller, as not competitors did, wrapped his products in individual doses to enhance safety and comfort for both hair stylists and customers avoiding the risk of oxidization by not putting the products in large containers.

Figure 2.1. *Accord Parfait Powder* (L'Oréal, 2018)

Eugène Schueller was quick to realize the value of one of his first bleaching solutions, claiming: "This little bottle holds a huge industry! One day, millions of brunettes will want to be blonde." The success was confirmed by many famous people, especially in the Hollywood environment, which give to the firm the wide appeal the founder wanted. Schueller strongly believed in the power of advertising as a tool for convincing people and directing to the product, he throwed many advertising campaign and, overall, he published Votre Beauté, the first monthly health of women & beauty magazine attracting more and more customers through his brand and convincing them that the appearance is important, and everyone should have taken care of himself. At that time, the shampoos in the market were not for everyday uses, they are made by black soap boiled in water mixed with soda crystals, L'Oréal finally gave to the market a real shampoo without soap (Fatty alcohol sulphates) that was considerably gentler on the air and sold in 1 litres bottles. Its name was Dop and was sold in France for the first time for the masses. In 1935 women are now enjoying greater emancipation and are revealing more skin, the sun tan is now the modern outlook. In line with this new trend, Schueller developed a skin-protection oil called Ambre Solaire. The product release date was perfect, in line with the French people preparing to take their first paid holidays in 1936, Ambre Solaire was the first icon of the "leisure age".

Figure 2.2. *Color Riche Quad* (L'Oréal, 2018)

Eugène Schueller, strongly believer of the concept that the economic imbalance between production and consumption was affected by insufficient purchasing power, raised his original idea of proportional salaries which assign proportional wages in relation to the changes in company sales, this leaded to the creation of profit-sharing scheme which will be embraced by 2,000 firms in 1947. As a pioneer of advertising Schueller was closely involved in the growth of the road-show radio talent contests that pave the way for popular broadcasts, he created the concept of sponsored programs, such as the Crochet Dop, travelling around France from 1947 to 1957 and attracting up to 50,000 people per day. Through this campaign he affirmed himself as the pioneer of modern advertising letting his products to know by million people. But L'Oréal did not stop there and wanted always more entering in several markets to expand its grounds and sell products for everyone. The Berlingot Dop was an outstanding success, particularly among children because the product was small, colourful and clear plastic packaged. In 1954, after three years of market research in the USA, the largest cosmetics market in the world, L'Oréal decided to expand itself in this region through its new product called COSMetic for AIR (COSMAIR) which became one of the most exclusive representative for L'Oréal hair products in the United States enabling continuous growing. In the same year the Group signed an agreement with the Société Hygiene Dermatologique de Vichy which let it to affirm its position among pharmacies. Through the figure of Marilyn Monroe and Brigitte Bardot, women around the world wanted increasingly to look like their idols and the Group position increased even more after the launch of its first colour-enhancing shampoo: Colorelle [11].

The 23th of August 1957 was the day when the pioneer of the Group Eugène Scheller died, but this event did not shock the firm, Francois Dalle gave a fresh impetus within the company and started to run a policy of targeted acquisitions for the expansion of the position of the Group in new market sectors, raised new channels and, always looking to the future, let the firm to continuously grow and reach new customers. During the year 1963 an important event for the company occurred: it started, for the first time, to be listed on the Paris Stock Exchange which gave it access to new important financial resources letting to increase its market capitalization more and more in the future. One year later, another historical event signed the history of L'Oréal: Lancôme, skincare, make-up and fabulous perfume brand which embodied the elegance and the French style was acquired and this occurrence let L'Oréal to undertake the road to becoming a luxury goods empire.

Figure 2.3. *Infaillible Blush Paint* (L'Oréal, 2018)

L'Oréal takes hairdressing salons into ground-breaking territory, complementing the usual colouring and styling services with a new concept: haircare, with a specialist range of products called Kérastase. What sets this concept apart is the combination of the best formulas to emerge from L'Oréal's research laboratories, the stylist's expertise and the way the care programme is tailored to individual hair types. The treatments are highly sophisticated with steps performed in a specific sequence, turning them into a real beauty ritual: diagnosis, scalp massage and expert treatment applied using specially developed techniques. A uniquely luxurious experience to enhance beauty and well-being. Another important brand the Group acquired was Garnier which enabled it to expand its portfolio for complementary haircare products but from a different perception and approach to haircare. The expansion of the company did not stop here but went ahead toward different complementary sectors, they reinforced one each other and the joint with Guy Laroche in 1966 for creating some fragrances pushed even more the firm in the luxury goods market, the result was Fidji which became a classic perfume with the unforgettable advertising slogan: "A woman is an island. Fidji is her perfume". The origin of the name "Eau de Toilette" derived from the traditional perfume made with Lancôme, fresh and clear, appealed to young women rather than classical perfume customers, "Ô de Lancôme" was the signature of the brand, one of the most effective. Successively, during the 70', the firm saw in Biotherm a highly original skincare brand to complement Lancôme and Vichy and finally the acquisition of Synthelabo, a pharmaceutical company, gave the Group the means to develop its dermatological and dermo-pharmaceutical activities. But during the 70' happened something more as the acquisition of Gemey, a make-up France brand specializing in foundations and face powders, gaining a significant position in the volume retailing make-up market in France, after that, in 1973 L'Oréal bought out the mascara brand Ricils and attached it to Gemey in order to expand its offer in all make-up segments. The Dernière Touche powder (Figure 2.4), the first compact one, is still on the market.

Figure 2.4. *Dernière Touche Powder* (L'Oréal, 2018)

The expansion in Asia, especially in Japan, increased the network over which the Group sold products and in 1975 the launch of Equalia was amazing. As never before, was launched in the market a product which laid the foundations for the concept of skin rehydration, the formula let the customer to restores and maintains exactly the right balance of water in the skin by the effects of the sun, wind and ageing. The success of Equalia also increased thanks to a factual advertising campaign letting the firm to sell worldwide more than 50 million units. Was the association 50/50 with Nestlé which enabled the creation of Galderma that was devoted to the worldwide development and to market dermatological remedies effective against skin, hair and nail complaints (Psoriasis, onychomycosis, acne, etc.), this was an independent organization active in the field of healthcare born in 1981. The interest showed by the firm not always looking at women, also men had an important role on the diversification strategy of L'Oréal, the idea was to replicate the success of Fidji by Guy Laroche for men, the solution was achieved with a new product called Drakkar Noir, an ultra-masculine fragrance whose mysterious name redolent of Viking conquerors and a captivating black package ensured huge success on new customers in the 1980s. In order to keep the Group in an eco-friendly position in the market the alliance of science and nature was reached during the first half of the decade having launched new range of family y6shampoos made from natural plant-based ingredients such camomile and wheatgerm, its slogan was: "Ultimate gentleness from the heart of plants" [9].

In 1985, L'Oréal created a complete line of hairstyling products: gels, mousses and sprays. The innovation resided in a veritable style toolbox allowing customers to become their own hairstylists. In the same year, the Group obtained the Ralph Lauren licence which let it to anchor its position in the luxury products market in the United States and in luxury fragrances of men. A new distribution network was reached: mail-order catalogues. Teaming up with Les 3 Suisses, a European leading mail-order company, L'Oréal launched a catalogue of beauty products, knew as Club des Créateurs de Beauté (Club of Beauty Creators), that were created by top designers such Agnès B. and Jean-Marc Maniatis. From 1988, under the leadership of Lindsay Owen-Jones, the Group embraced profound transformations creating a more balanced range of activities centred around five core businesses: haircare, skincare, hair colour, perfume and make-up. He created a portfolio of 23 international megabrands designed to meet the needs of women and men throughout the world. Next, in 1989, L'Oréal acquired Helena Rubinstein, an American brand of skincare products which let the firm to affirm itself in the luxury market. This acquisition putted the basis of a license contract with Giorgio Armani allowing the company to promote the Helena Rubinstein brand in fashion. The acquisition of La Roche-Posay definitively consolidated L'Oréal dermatological expertise and its presence in pharmacy networks. In 1990, Lancôme launched Trésor (Figure 2.5), an incredible success which rapidly became the best-selling perfume in the world and it is still on the top 10 worldwide.

Figure 2.5. *Lancôme Trésor* [7]

In the wave of success, in 1992 the Group inaugurated its ultra-modern factory in Aulnay-sous-Bois located in France where primarily Garnier products were manufactured; its design reflected the concern of the Group for environmental protection and workplace safety indeed the complex was awarded the prestigious architectural prize: L'équerre D'argent. Two years later L'Oréal expanded itself toward Middle-East by creating a subsidiary in Israel. A great occurrence, in 1996, signed another turning point for the firm: the acquisition of Maybelline, the leader in mass-market make-up in the United States. This event opened the doors for the crucial expansion of the Group in Asia, especially in China. It made L'Oréal the uncontested leader in the United States, but it also established the company as the world leader in mass-market make-up. Two new products were launched in the market, the first by Garnier, named Fructis, characterized by its fluorescent green bottle, its unique formula enriched with active fruit concentrate, its scent and the off-beat tone of its multicultural advertising made a splash around the world; the latter, embodied the sophisticated and understated Armani style for men, Acqua di Giò gained an unabated success since it first hit the market. It remained the leading fragrance for men worldwide. A corporate sponsorship with UNESCO to launch the "For Women in Science" Awards marked in 1998 the beginning of a new era of social responsibility for the Group. The new millennium brought further changes into the Group: Watershine was the number one lipstick in the world and Série Expert the line of highly efficient professional hair care products having effect on the very heart of the hair fibre due to the high molecular precision innovation. In February 2000, L'Oréal formalized its values and guiding principles signing the Code of Business Ethics which was distributed to all employees throughout the world [7].

In 2001 L'Oréal had joined the "World Business Council for Sustainable Development" with the aim to stimulate the exchange of expertise in economic, environmental and social matters; in the same year the Group acquired Biomedical, an American brand of professional corrective cosmetic products, combining safety and efficiency, Biomedical had joined the Group brand with the highest dermatological valence: La Roche-Posay. The 2002 was marked by the association with Nestlé letting L'Oréal to enter in the market of nutritional supplements for cosmetic purposes with the creation of Innéov in order to develop this booming market, besides the Group, along with 2,000 other businesses, subscribed to the ten principles of the Global Compact, a sustainable development initiative launched by the UN in 2000. Speaking about the products, one of the most controversial was Natéa (Launched in 1998) which nourished hair while coloring it. The issue was that the name conjured up the idea of nutrition for speakers of Romance languages, then was not well understood in the U.S (A crucial market for Garnier). Thus, the brand was renamed Nutrisse, a more accessible name, and it soon became the World number one in terms of hair coloring sales. In 2004 the Group opened a plant for consumer products in Pune, close to Mumbai with the purpose of meeting L'Oréal quality standards for the Indian market, this centre demanded GHP hygiene standards which would later be applied in cosmetics around the world.

Figure 2.6. *Accord Parfait Trio Lumi* (L'Oréal, 2018)

For the first time in the mass market, L'Oréal Paris' Men Expert offered men a range of advanced skincare which contributed to the boom in male cosmetics through the motto: "Because they worth it too". According to the president and founder of Diversity Best Practices organization Ms. Edie Frase "L'Oréal's efforts to make diversity a business imperative as much as a social one, are just not worthy of recognition, they are an extraordinary example for other companies to follow", in this occasion the Group earned the first Diversity Leadership Award thanks to its commitment to address the diversity of its employees, customers and suppliers.

Figure 2.7. *Le Petite Palette Nudist* (L'Oréal, 2018)

Not by chance, in 2005, L'Oréal Professional Products Division and UNESCO signed a cooperation agreement to educate hairdressers about AIDS prevention using the global network of hair salons. Lindsay Owen-Jones received in New York the Anti-Defamation League's International Leadership Award for him fight against discrimination; Abraham H. Foxman, National Director of the ADL, said that "Sir Lindsay has taken his vision and put it into practice, making L'Oréal not just the leading cosmetic company in the world, but a leader in promoting diversity and respect for culture and identity setting standards to be emulated. L'Oréal and ADL have a shared vision of celebrating 'A Planet of Diverse Beauty'." In the heart of Paris in 2006, was built The Hairdressing Academy, the largest training centre in the world. Inspired by Didier Gomez, one of the France's great designers, it early became a miracle of technology; this prestige site was a powerful image booster that underscored the importance that the Group attached to training and partnering hairdressers. In the same time a new chapter in the Group history begun. Lindsay Owen-Jones became Chairman of the board of directors and Jean-Paul Agon was appointed Chief Executive Officers with operational responsibilities. Having worked alongside Lindsay Owen-Jones since 2005, the new Chief Executive Officers put his own stamp on the company aligning it with his vision. He wanted to make the Group a great place to work and a "great citizen of the world". Pro-Xylane was the first cosmetic ingredient developed by L'Oréal green chemistry business, a bio-degradable and not eco-toxic. This bio-mimetic agent duplicated the skin's natural biological processes delivering anti-ageing action and it was incorporated into the formulas of new anti-ageing products developed by Lancôme, Vichy and L'Oréal Paris. In order to encouraging education, promoting scientific research and helping vulnerable people L'Oréal created its Corporate Foundation making a powerful statement of social responsibility, furthermore in 2007, enriched by employee feedback, a second edition of the Code of Business Ethics was launched. One year later with the acquisition of Yves Saint Laurent (YSL) the Group reinforced its Luxury Products Division becoming world leader in selective distribution. The 2009 was the centenary of L'Oréal. In 2011, Jean Paul Agon became Chairman in addition to CEO while Lindsay Owen-Jones had become Honorary President. On 23 October 2013, Jean Paul Agon announced the new commitments of L'Oréal to reduce by 2020 the footprint of the company while achieving its business ambition. The Group committed to integrate sustainability along its value chain while sharing its development with communities: "Sharing Beauty With All". This project covered four sections: Innovating sustainably, Producing sustainably, Living sustainably, Developing sustainably with employees, suppliers and communities. On 2014, during the International Women's Day, L'Oréal confirmed its strong ethical commitment in Human Rights, diversity and social responsibility, first of all by signing the Women's Empowerment Principles, a collaboration of UN Women and the United Nations Global Compact. A revolution occurred when the Group announced the launch of the first connected beauty digital innovation called "Makeup Genius" exclusively available through L'Oréal Paris (Its most famous brand), which enabled consumers to test makeup products simply using their mobile phone or tablet as a virtual mirror; customers can virtually test the products and bought them instantly scanning a bar code. In this way, the company increased its Before and After selling service offering a new digital era of e-commerce in this sector. For the third year in a row, L'Oréal has been recognised as a global leader for its climate change mitigation strategy in the annual Carbon Disclosure Project ranking (CDP). The CDP is a no profit organization which measures and monitors environmental indexes evaluating both the performance and the transparency of climate change mitigation strategies of firms. The Group has been given an "A" ranking for its management of its carbon footprint and its climate change strategy, as well as a score of 99/100 for the transparency of its policies. On January 6^{th}, the Group unveiled My UV Patch, the first ever stretchable skin sensor designed to monitor UV exposure. Not by chance, this new technology arrived at a time when sun exposure had become a major health issue. L'Oréal chose La Roche-Posay in introducing the new technology; the UV Patch is a transparent adhesive that, unlike the rigid ones proposed by competitors, it stretches and adheres directly to any area of skin that consumers want to monitor. The patch contains photosensitive dyes and changes colour when exposed to UV rays indicating varying levels of sun exposure. Finally, on March 7th, L'Oréal has been recognised by the Ethisphere Institute, a global leader in defining and advancing the standards of ethical business practices, as a 2016 World's Most Ethical Company [10].

2.2 The Settimo Torinese Plant

In this paragraph, it will be introduced a general overview of the Settimo Torinese plant, one of the most important sites of the Group producing output for Italy and other countries all over the world.

It was built in 1960 and initially produced hair styling, shampoo and skincare products. Only in 2004 the plant started to produce cosmetics powders, the type of production involved in the case studies which follow. Nowadays, it produces three types of products: mascara, shampoo and cosmetics powders that are divided in three production units within the plant and they are characterized by their own technology. The factory, made of about 400 people, is one of the best in producing output for the Group. This high productivity was achieved through a clear and systematic organization established within the plant, furthermore, the site is a clear expression of L'Oréal business and ethics principles. Social and environments commitments are stated pillars for the firm. These applications are strongly implemented, starting from environmental regards to safety ones (Figure 2.8). All the initiatives aimed to eliminate injuries in daily work, to respect the high-quality standards and to promote an eco-sustainability enterprise model both internal and external, involving suppliers in an eco-Lean perspective. The production site is certified ISO 9001 (Quality) from 1996, ISO 14001 (Environment) from 2004, OHSAS 18001 (Safety) from 2005 and ISO 50001 (Energy) from 2016. Since 2010, the Wall to Wall project is being carried out and let to save 1.000 trucks per year devoted to products transport allowing a reduction of CO2 emissions round about 100 tons per year. The Wall to Wall initiative focuses on the internalisation of bottle and container supplier for shampoo articles and the internal assembling of mascara packaging articles. Inside the plant there is a dedicated place (The shampoo articles are produced by a supplier, instead the mascara articles are assembled internally by the Group) to produce / assemble packaging articles at 0 kilometres reducing a lot the costs related to supply chain management. All the companies related to the Group undergone several validation procedures, primarily in quality and environmental terms, in order to become suppliers of the Group. This policy enhances the supply chain value allowing better business relationships, trying always to achieve a win-win situation in which all the stakeholders involved gain something by the relationship.

From 2005 and 2016, concerning environmental management, there were achieved by the plant important results about water, waste and energy consumptions:

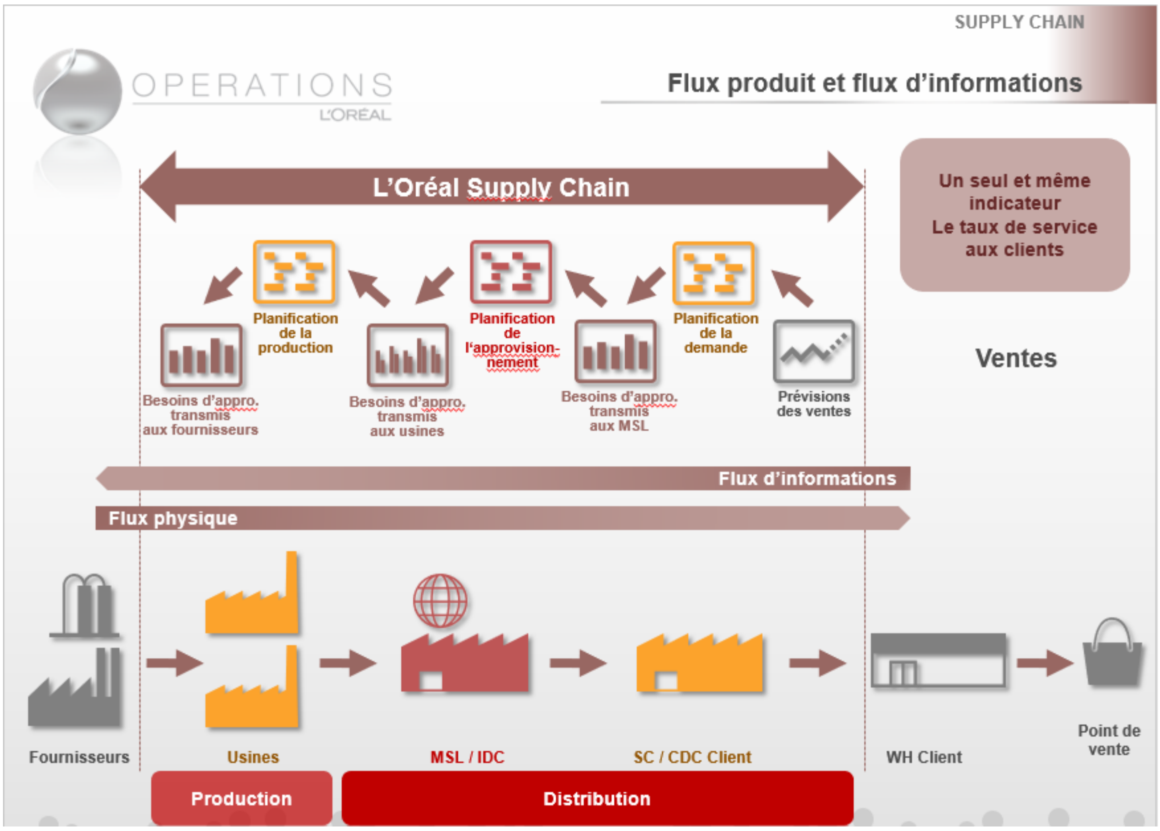
- Water consumption (Litres/finished product) -47%.
- Energy consumption (Both electric and thermal) -18%.
- 100% waste enhanced (From 2015 zero wastes in dump).

Nowadays, in cooperation with Settimo Torinese district, the “Neutral CO2 Emissions” project is allowing to the manufacturing site to save a potential CO2 emission more than 9.000 tons per year through the adoption of sustainable energy sources as a district heating system, solar cells and biomass powerhouse [8]. The revenues of the plant are continuously growing from 2012, nowadays it is accounted for 271.213.606,00 € [15].

Figure 2.8. *Quality, Safety and Environment policy attachment* [8]

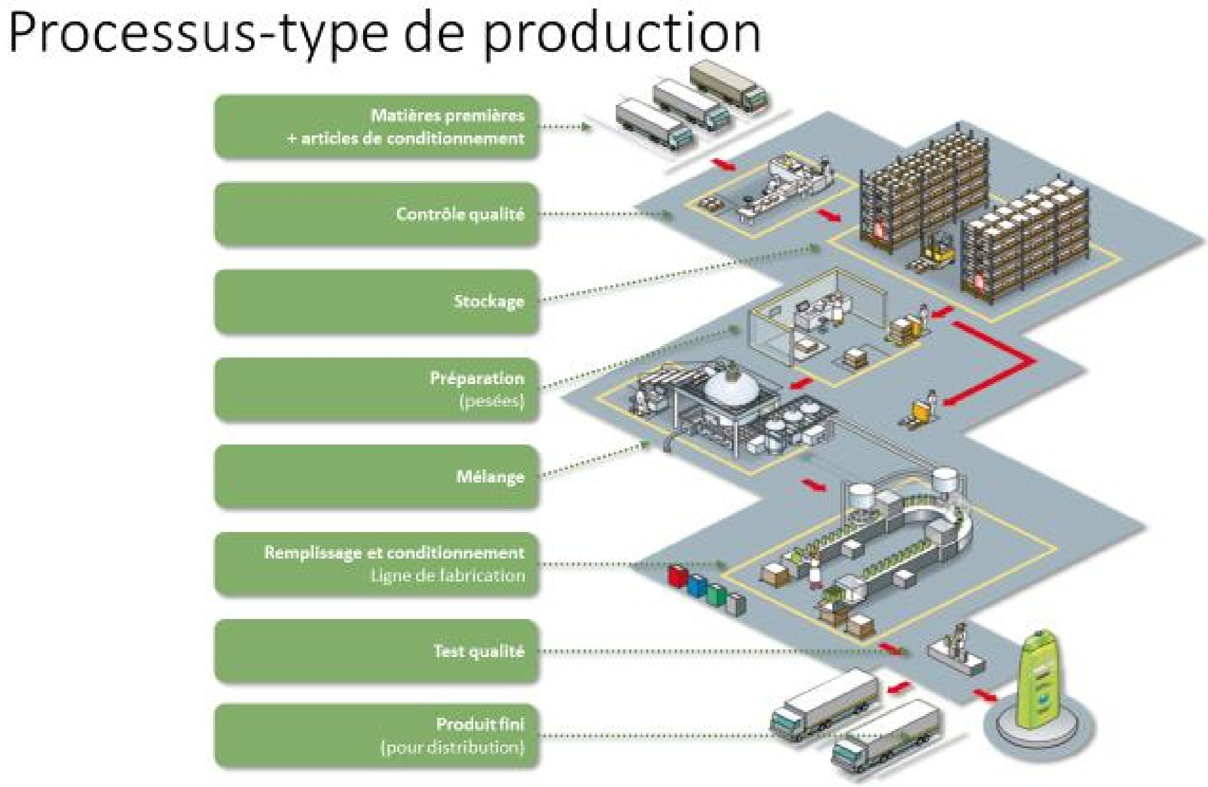
The process which creates the final product (Figure 2.9) starts from a communication by branches about the demand forecasted to the Supply and Operations Department, then the Master Production Scheduling Department, based on previous Department data, elaborates a monthly production plan determining the articles requirement to the various usines (Production plants) which, in turn, send the packaging articles requests to the suppliers. Once the articles required for starting production arrived, the manufacturing process can start.

Figure 2.9. *L'Oréal Supply Chain* (L'Oréal internal source)



Each time the plant needs a new packaging article or launches a new product, the creation of a reference is made by central servers located in Paris through Research and Development and Packaging departments which send the codification to SAP platform to manage master data and branches the information to several local servers for production purpose. The plant manufacturing process (Figure 2.10) is structured as follow. Once articles arrived from the suppliers, they follow the standard flow: Stocking, Weighing, Processing and Packaging during which raw materials, semi and finished products are constantly inspected through quality standards along the value chain, especially in the first moment they arrive and the last step before being shipped. The raw materials come directly from the automated warehouse to the weighing and processing areas in a direct flow, instead the packaging articles and semi-finished products are delivered by Automated Guided Vehicles (AGV) immediately after the informatic request by the operators. After the manufacturing process, the finished products are rapidly pushed out from the plants toward a central platform which, in turn, processes and delivers them to several branches, ready to sell.

Figure 2.10. *Manufacturing Process Flow* (L'Oréal internal source)



2.3 Lean Approach

L'Oréal is very proactive with respect to the Lean approach, it uses and applies several Lean tools aiming to reduce wastes. Within this production site (Settimo Torinese) is very easy to happen by several visuals such as pictograms or photos and descriptions attached on many places from machines to walls. The Visual Management technique (Paragraph 1.2.4) is used a lot for reinforcing the knowledge and know-how of the stakeholders involved in the working day, it is especially useful for the operators and technical support staff to keep the standardization of their activities achieving and maintaining improvements done. Several OPLs, for instance, are disseminated over critical points within the line. The OPLs are laminated sheet printed in a smaller format than A4 in which a simple instruction is recognized, it helps the operators to remember how a specific action has to be done. It is a very useful technique for everyone who forgot an instruction in relation to a specific standard procedure. The OPL (Figure 2.11) allows to minimize the variability among people in conducting daily work and to reduce mistakes during the jobs. It aims to three different purposes: training, solving technical or management issues and allowing continuously improvement. At a certain point of time, once the procedure is acquired by everyone, the sheet should be removed to make valuable space for something else.

Figure 2.11. *OPL Example*

The 5 Standards are used for sorting, simplifying, scanning, standardizing and sustaining the work environment and maintaining the correct behaviour in relation to it. Once in the work place everything (Stations, tools, packaging articles, etc.) is sorted, simplified and cleaned, the operators benefit from a simple and clear work environment and find themselves in an optimal state to carry out their activities because everything is put in order and they exactly know where things are. "To simplify" implies to mark the essential objects in a way that they can be assigned to certain positions and everyone can find them at the right place and return them to the right position at a reasonable motion time (Paragraph 1.2.3). L'Oréal implements five minutes routine to verify if these "Standards" are perfectly understood by the operators letting the sustainability of the outcomes achieved. Standard Operation Procedures (SOP) are related to the previous concepts and they are useful for maintaining standardization among activities. Typical examples in the firm are the SOP's used for cleaning up the line. Primarily, all the operators are trained for the specific task, also the procedures are recognized in dossiers in which quality, performance and safety specifications are written. The Performance Department is one of the main actors involved in continuous improvements such as making what they call Quick Kaizen. Not by chance, Quick Kaizen activities result from collaboration between Production and Performance departments. The Quick Kaizen event (Paragraph 1.2.6) is a moment in which an improvement is done, it could regard a technical solution related to a portion of a machine or something related to a specific organizational change within the production site. It is characterized by simple but rigorous rules, such as the necessary involvement of all the stakeholders affected by the problem, the timing (Restrictive) imposed in doing the actions and the existence of (Performance) indicators which let the stakeholders to understand if these actions are successfully accomplished.

In the light of continuous improvement, PDCA (Paragraph 1.2.7) is a tool used by the firm for planning and doing a simple improvement in response to an issue emerged during working time on the lines in order to solve those problems which constraint the production. When an issue emerged, it is recognised in a book or a digital paper, there are weekly meetings in which the team faces and analyses these issues. Through the PDCA activity the solving procedure is planned on a specific date, the involvers are specified, after that the “do” phase become effective and through specific indicators, which fix the expected outcome to achieve, the “check” phase ends. Finally, “act” stands for maintaining the achievement. This phase could have an infinite duration over time because it simply means to standardize the enhancement done. The SMED application (Paragraph 1.2.9) is also part of the firm’s DNA. Each time a changeover is conducted the procedure follows the principles of SMED by Shingo. In practise, there is no activities clustering (Internal and external) just because it was done years ago, so the procedure is kept over time. Each mechanic knows how to conduct a changeover, in doing this they prepare spare parts and technical tools needed for the changeover before starting it, they use nominal values (Attached in the modules of the line as a A4 sheet) which help them in quickly recognising the values of the machines and they also have a standardize method in carrying on the changeover. The discussion will follow up in the next two chapters in which a deep analysis on practical cases will be conducted. To conclude this paragraph, to remember that in paragraph 1.2.1 the concepts of Pull System and Kanban were discussed. As it previously said, these methods cannot be totally applied in the large consumers goods cosmetic industry in which, in turn, is preferred to focus in large production volume that ensures the right delivery to the customers.

3. APPLICATION OF SMED TO CLEANING CHANGEOVER

This chapter analyses a cleaning changeover conducted in the firm (Settimo Torinese plant) with the support of the Performance Department and the operators who work in the line. There will be an introduction in order to fix the important steps and goals and then an AS-IS and TO-BE analysis will be carried out for improving the process. To notice that this chapter and the following one are related because they share the same goal: the reduction of setup time. It is nice to develop them in parallel and see how the intrinsic differences affect the realization of the case studies: one examines a cleaning changeover, the other a mechanic / technical one.

3.1 Case Study Introduction

The first case study regards a press line for cosmetics powders. These types of lines press the powder into a pan forming a sort of cake, letting other packaging lines to make the product in a second step. Indeed, they need to be cleaned each time switching from a type of powder to the next one. The cleaning process is crucial for this type of industry because the quality of the products must be guaranteed, becoming one of the most important thing to do. Each time the line works on one type of powder, it dirties the line in several parts, there could be different powders which own different features (Chemical composition for instance), in turn they could dirty the line in relation to them. The cleaning process should be intended as SMED application because it actually is a changeover operation which lets the line to switch from working on a product (i.e. type of powder) to another one. The switching process is composed by a set of operations which are essentially devoted to clean the station through some cleaning tools by the operators. The difference between the two case studies (Cleaning and Technical one) detailed in this thesis relies on the type of job, changeovers are strongly different among them because they refer to different tools, different working time and various steps but with the same goal: to do it in the shortest time possible because they are non-value-added activities or wastes that have to be minimized. It will be listed a set of operations needed for doing correctly the job, the necessary tools and the motions of the operators. The tasks and the sequences will be analysed, it will be investigated the chance to switch internal operation to external ones. Remembering that internal operation is the one which is conducted when the machine is not running instead the external one could be conducted when the machine works. The unnecessary tools, operations and, also wastes of motion will be eliminated.

3.2 AS-IS Situation

Here is going to be introduced the steps for making a changeover, as L'Oréal does. The logic of the SMED concept is always the same: observing the process, clustering the activities by means internal and external ones, moving as much as possible the internals to externals and trying to minimize the time in which the activities are carried out, especially the internal ones. It was get in consideration two cleaning changeovers (Table 3.1 and 3.2) on the basis of the operator's skills, the first one was made with a skilled estimated operator (In terms of cleaning quality) instead the second one was conducted by a less skilled operator. The main goal of the analysis is to reduce as much as possible the time for completing the setup. The changeovers treated different type of products and belonged to distinct lines. The changeovers were examined and divided in their main activities considering the time for each one. To notice that the second changeover (Table 3.2) is just examined for comparation purpose (In relation to the first one on table 3.1) and to underline the criticalities in the cleaning process. For this reason, the TO-BE situation will be connected only with the first changeover (Table 3.1) indeed it will be conducted with the same features (Operator, product and line) as an outcome of the AS-IS changeover (Table 3.1).

Table 3.1. *AS-IS Cleaning Changeover*

OPERATOR	[redacted]
LINE	
PRODUCT	

CHANGE PRODUCT COMPACTING ACTIVITIES

	ACTIVITIES	TIME (MIN)	%		
0.1	Clean bench preparation	3	\		
0.2	Blade cleaning	1	\		
1.	Last pieces checking	3	4%	START	16:20
2.	Line emptying	3	4%		
3.	Previous batch declaration, opening new batch	4	6%		PRELIMINAR EXTERNAL ACTIVITIES
4.	Semi-worked bench cleaning	1	1%		PRE-CLEANING, PREVIOUS BATCH
5.	Defects drawer cleaning	1	1%		
6.	Hopper cover cleaning	2	3%		
7.	Hopper disassembling	1	1%		
8.	Hopper cleaning	6	9%		
9.	Partial machine cleaning	1	1%		
10.	Lateral hopper ramp cleaning	1	1%		
11.	Waste disposal	0,5	1%		
12.	Little hopper disassembling	1	1%		
13.	Little hopper cleaning	5	7%		CUMULATIVE TIME FOR REMOVABLE COMPONENTS 15
14.	Chute disassembling	1	1%		
15.	Chute cleaning	2	3%	COMPONENTS CLEANING END - MACHINE CLEANING START	
16.	Machine cleaning	31	45%		
17.	Reassembling removable components	3	4%		
18.	On the ground cleaning	1	1%		
19.	Clean bench and tools repositioning	2	3%	END	17:29
	TOT	69,5	100%		

METHOD: Disassembling and cleaning, reassembling everything after the machine cleaning

As is can be seen the AS-IS situation (Table 3.1) shows two preliminary steps (0.1 and 0.2) that have to be intended as external activities, the next three steps are referred to the previous batch and they are the inspection of the last pieces, the depletion of the line and the physical and informatics declaration of semi-worked items (Phases 1-2-3). They are internal activities. Because all other activities are internal too, they have to be minimized and translated, as much as possible, into external ones, in line with SMED methodology. These activities comprehend the proper cleaning phase in which several line parts are disassembled and cleaned by the operator with cleaning oil, aspirator tube and a simple sponge. The critical step which takes a huge time, as it can be easily founded in the table, is the machine cleaning (Activity 16), namely the cleaning of the internal machines such as flat bed, tools inside the machines and protection carters. Finally, the last steps are removable components reassembling (Activity 17), on the ground cleaning (Activity 18) and repositioning of cleaning tools and bench (Activity 19). The total duration of the observed changeover is 69,5 minutes and somehow reflects the average time devoted to it into the firm. To notice that is also indicated the type of product to be cleaned and its chemical formula number because, as it was explained previously, it affects the difficulty of the operator to clean the station. The name of the operator such as the line and type of product have been deleted for privacy reasons.

Table 3.2. *Other AS-IS Cleaning Changeover*

CHANGE PRODUCT COMPACTING ACTIVITIES

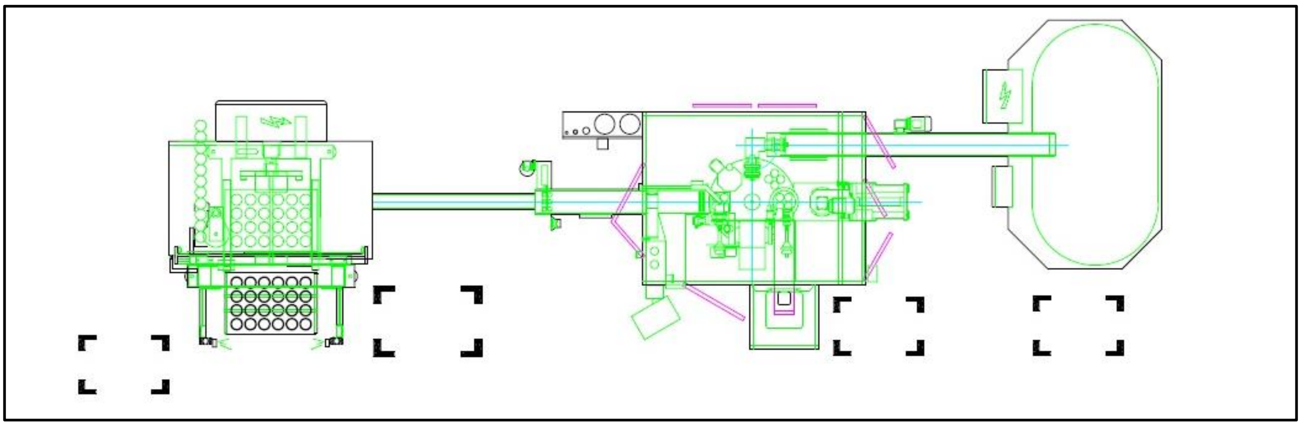
	ATTIVITÀ	TEMPI (MIN)	%
0.1	Clean bench preparation	2	\
0.2	Blade cleaning	1	\
1.	Last pieces checking	3	6%
2.	Line emptying	2	4%
3.	Previous batch declaration, opening new batch	3	6%
4.	Semi-worked bench cleaning	1	2%
5.	Defects drawer cleaning and neighbouring	2	4%
6.	Hopper disassembling	3	6%
7.	Hopper cleaning	2	4%
8.	Lateral hopper ramp cleaning	4	8%
9.	Chute disassembling	1	2%
10.	Chute cleaning	4	8%
11.	Hopper zone cleaning	6	12%
12.	Hopper reassembling	1	2%
13.	Little hopper disassembling	1	2%
14.	Little hopper cleaning	4	8%
15.	Little hopper zone cleaning	3	6%
16.	Little hopper reassembling	2	4%
17.	Partial machine cleaning	5	10%
18.	Hopper cover cleaning	3	6%
19.	Clean bench and tools repositioning	1	2%
20.	On the ground cleaning	1	2%
	TOT	52	100%

METHOD: Disassembling single piece per time, cleaning it and close to it in the line, then reassembling ciclically

OPERATOR	[redacted]
LINE	
PRODUCT	
START	08:36
END	09:28
PRELIMINAR EXTERNAL ACTIVITIES	
PRE-CLEANING, PREVIOUS BATCH	
CUMULATIVE TIME FOR REMOVABLE COMPONENTS	14

This second observation (Table 3.2) was examined and it was got the activities time. regards the same cleaning operation of another operator over a different press line. More or less, the two tables (Table 3.1 and 3.2) are the same, or better, the operations carried out are the same but, the sequence of them changes because the methodology is different from one operator to another. The time spent for the process (52 minutes) is quite less with respect the first one due to four main reasons: the order of the sequences by the two operators, the difference in the powder, the different line and the quality of cleaning. The first reason resides on the different method used by the operators, the first one disassembles the parts of the line, cleans them, then tidies up the dirty over the line and finally re-assembles the removable parts. Instead, the second operator uses a different method: she disassembles mechanical parts, cleans up them and around them over the machines, then re-assembles them in the line. She makes these steps cyclically until the line is completely cleaned. The difference in the type of powder impacts on the time spent in making the cleaning process, the more grease is the powder the more will be the duration of the changeover. Another reason of the difference in changeover duration resides in the different line cleaned. To notice that the layout of the lines is the same, what changes are some components inside them. The first line is easier than the second one in disassembling and re-assembling the parts due to the difference in the hooks. Of course, it is strange that, considering that constraint, the second changeover time is shorter than the first one. The explanation of that is ascribable to the cleaning quality which results poorer in the second observation. For a better understanding of the lines it follows the typical layout of them (Figure 3.1). It is composed by, starting from the right side, a vibrant tank which transports the pans toward the press machine in the central position, then through a conveyor the semi-worked items arrive in the pallet machine which moves the items into several trays.

Figure 3.1. *Layout of a Press* Line (L'Oréal internal source)



3.3 Criticality Definition and Case Study Requirements

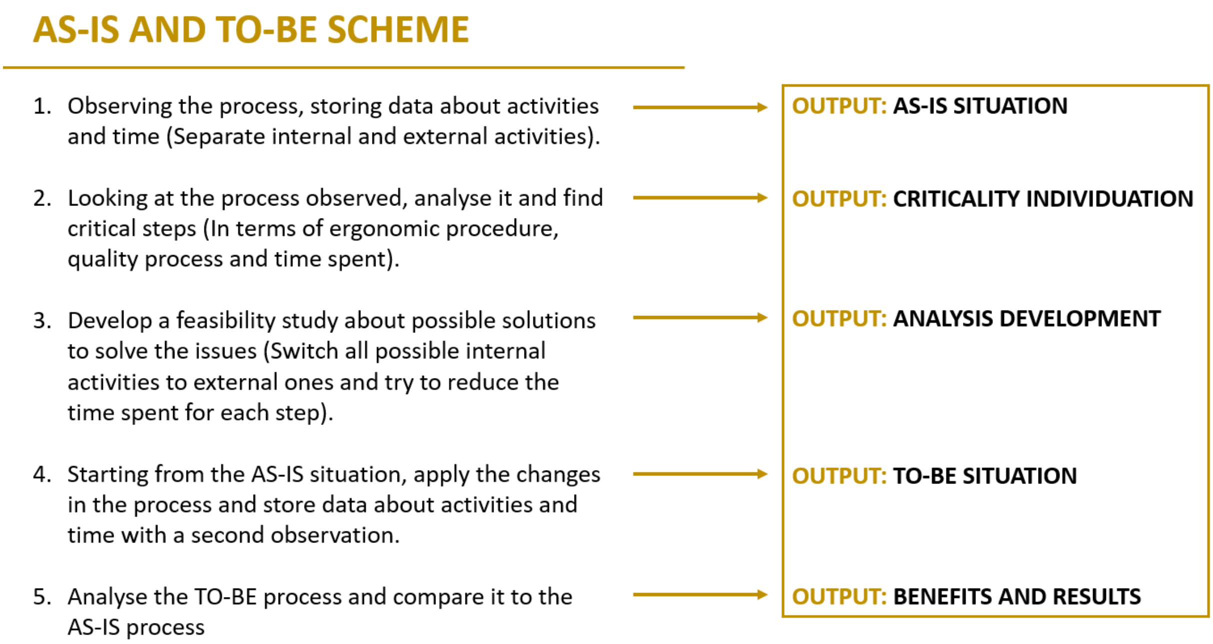
Here is going to be introduced the case study requirements and the individuation of the criticality related to the process which have to be solved in order to decrease the time spent for. It is essential to notice that the involvement of the Performance Department is required for the correct development of the case study, it provides the necessary data for the analysis and indicates the need of it. It was seen, thanks to Performance Department, that the operators spend too much time devoting to clean the press lines and for this reason must be scaled down. In particular, through the help of the Loss Analysis, a collection of data about the lines in which performances of them are stored, that indicates which line be worth considering against the others in terms of performance loss. Note that the work is conducted no matter the lines performances because the goal is to reduce the cleaning time for all machines which are very similar one each other. For this reason, the loss analysis was just treated as aid of the changeover work, then not only the worst line (Resulted from the Loss Analysis) was considered but everyone. The Loss Analysis is omitted for legal and privacy firm reason. It is also important the involvement of the operators which must be convinced of the work requirement and also the participation of managers for letting the work believable increasing the chance of exploit the results. Finally, the firm has to provide the necessary tools for doing correctly the job such as time devoted to it and analysis tool to optimize the result. The situations described above show some inefficiencies along the processes due to incorrect tools, waste of motion and wrong procedures. Notice that the product cleaned in the first analysis with respect the second one is a greaser powder type which sticks itself on the machines, thus it is a non-optimal situation for reaching a shorter setup time. First of all, the cleaning pump does not arrive to clean every part of the line, some edges are not cleaned due to the difficulty of the operator to arrive in, the conclusion is that the cleaning pump spout is too big and has to be reduced to clean each part of the line avoiding contamination. This adaptation does not reduce the setup time, instead could increase it but, on the contrary, it may allow a better cleaning quality. In the first observation, during phase 6, not only for disassembling the hopper cover the operator needs the help of a second person, but the hopper cover cleaning is performed in position of knee making the operator uncomfortable causing more frequent diseases in the long run. Further considerations could arise in seeing how the operator cleans the internal machines. Firstly, not all parts of them are reachable and cleanable from the operators, independently from their stature, secondly, the operators often clean without a rigorous method. For instance, the action to clean firstly some parts that are physically below to the other ones, forces the operators to reclean the station. In the second case the quality of the cleaning process is very poor resulting in the lack of cleaning of some parts which, on the contrary, are carried out in the first case. The difference of the two methods leads to a variability in the process which must be decreased, and the process has to be standardised.

3.4 Analysis Development and TO-BE Situation

In this paragraph it will be analysed the wrong procedures, useful methodologies and tools will be introduced for decreasing setup time and achieving a better cleaning quality. The TO-BE analysis will be conducted as an outcome of the first AS-IS cleaning changeover (Table 3.1). The other AS-IS cleaning changeover is only treated for deeply understanding the process and for comparation purpose, it will be not developed as TO-BE.

In order to decrease the setup time some adaptations may be carried out. The hopper may preliminary be degreased, during run time, with a paintbrush once the last powder tank is loaded. This step allows a fast hopper cleaning during the changeover. The step 9 could be avoidable because the hopper zone cleaning in the line should be conducted in the step 16 in which the inside of the machines is cleaned (Table 3.1). Cleaning only one part of the line during the pieces cleaning phase is a waste of motion for the operator and could become a repetition for the reason that in the reassembling phase the motion of the pieces dirt a bit the line leading to a double cleaning. This issue introduces the necessity of the activities separation and clustering, improving the motions of the operator and mental order during changeover. Also, during activity 11 (Table 3.1), while the operator is disassembling other pieces of the machines to be cleaned in the cart, he also dumps the garbage moving from cleaning cart position to garbage box position and vice-versa, an unnecessary operation that would be conducted afterwards. The hopper cover should be cleaned in a more ergonomic position, for instance over the cleaning cart. To notice that in tables 3.1 and 3.2 are also indicated the cumulative times spent in cleaning the removable parts of the line; the reason is that an improvement will be done on this process (Paragraph 3.5) and the time devoted to it is an indicator which let to monitor the time wasted. Some sequences must be adapted and rearranged in order to save time during the process. An example could be that the cleaning operations must be conducted from the top to the bottom avoiding the repetition of some activities and also the layout structure of the line might be changed letting the operator to reach those parts which currently cannot be cleaned. Furthermore, the second case (Table 3.2) shows up a bad organization of the operator during the process, indeed throughout the whole changeover the operator put the hopper cover in front of the line so that the cleaned powder falls down on it, decreasing the time spent for ground cleaning activity. Actually, it is not true that this operation decreases the time spent for another one (Ground cleaning, activity 20), on the contrary, it just constraints the operator in his motions during the changeover putting her in a non-ergonomic position. The way to conduct the activity must be change. It follows the AS-IS and TO-BE scheme (Figure 3.2).

Figure 3.2. *AS-IS and TO-BE Scheme*



The scheme offers a way of thinking to improve the process giving as an output subsequent steps which allow mental order that is needed for correctly analysing the process and finding the best way to reach solutions and improve the changeover.

The different applied methodologies in the two observations (Table 3.1 and 3.2) suggest the necessity to standardize the procedure. This operation leads to a reduction of process variability and let mistakes and bad actions to emerge each time they occur. Furthermore, it has to be noticed that the lines are different from hooks point of view, indeed this diversity within the lines suggests the standardization, once again, of the components. This change could lead to a double benefit: the first regards the time reduction during setup achieved by the operators facing, no matter the line, the same procedure, the second is again a setup time reduction for the technical support staff (i.e. mechanics), switching from one product format to another, which always work with the same components reducing variability and mistakes during the work. All these changes have to be applied for the reduction of changeover times in both cleaning and technical one. It follows the TO-BE situation (Table 3.3) of the same operator in the same line with the same product of the first AS-IS cleaning changeover (Table 3.1).

Table 3.3. *TO-BE Cleaning Changeover*

	CHANGE PRODUCT COMPACTING ACTIVITIES			
	ACTIVITIES	TIME (MIN)	%	
0.1	Clean bench preparation	3	\	
0.2	Blade cleaning	1	\	
0.3	Preliminary hopper degrease	1	\	
1.	Last pieces checking	3	6%	START
2.	Line emptying	3	6%	
3.	Previous batch declaration, opening new batch	4	8%	
4.	Disassembling removable components	2	4%	
5.	Semi-worked bench cleaning	1	2%	
6.	Hopper cover cleaning	2	4%	
7.	Chute disassembling	0,5	1%	
8.	Chute cleaning	2	4%	
9.	Machine cleaning	26	54%	
10.	Reassembling removable components	2	4%	
11.	On the ground cleaning	1	2%	
12.	Clean bench and tools ripositioning	2	4%	END
0.4	Removable components cleaning in washing machine	3	\	
	TOT	48,5	100%	
METHOD: Disassembling and cleaning, reassembling everything after the machine cleaning				

OPERATOR	[redacted]
LINE	
PRODUCT	

PRELIMINAR EXTERNAL ACTIVITIES
PRE-CLEANING, PREVIOUS BATCH
CHANGE IN THE ACTIVITY
FOLLOWING EXTERNAL ACTIVITY

WASHING MACHINE TIME FOR CLEANING COMPONENTS	3

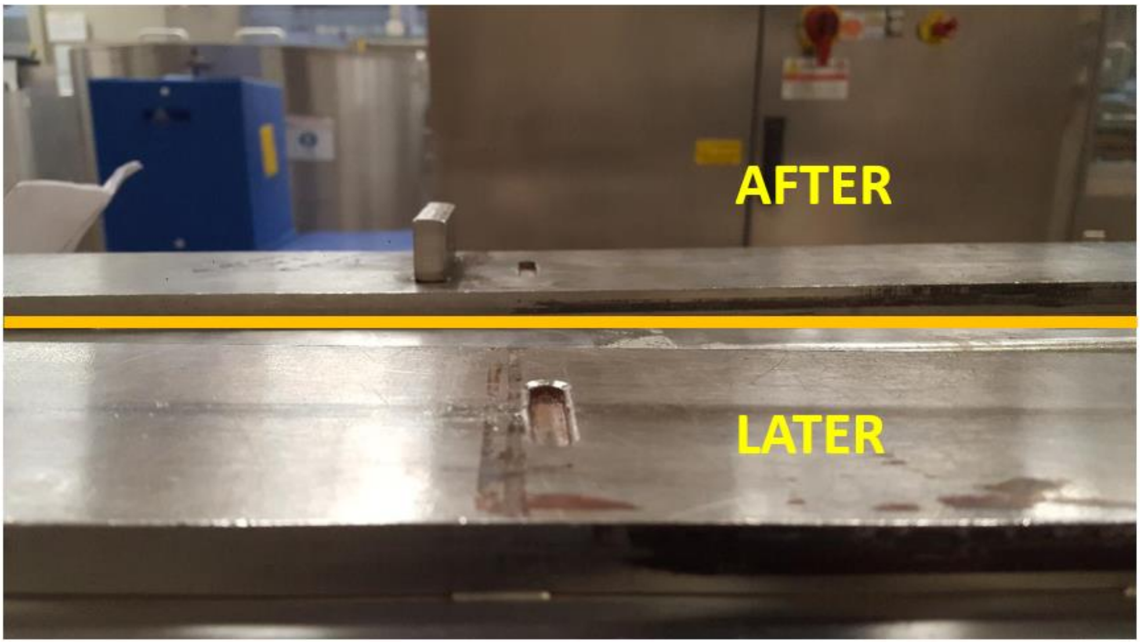
3.5 Benefit Analysis AS-IS_TO-BE and Results

Comparing the AS-IS with the TO-BE situation (Respectively table 3.1 and 3.3) some real tested benefits have been emerged due to several changes in the procedure. The benefits achieved through the analysis can be clustered as follow:

- Cleaning quality increased
- Ergonomic procedures achieved
- Setup time decreased

The TO-BE situation (Table 3.3) is an outcome of the first AS-IS changeover (Table 3.1), it was documented and conducted again after the changes in the procedures. The first benefit was achieved through the implementation of a new aspiration tube with a reduced terminal size, letting the operator to reach several more parts of the line. Notice that the decreased setup time let the quality to increase because the gained time might not be treated for production purpose but again for the cleaning one; in this way the operator can tidy up more parts of the line that were not cleaned before. The gained time with respect to the AS-IS situation (Table 3.1) accounts for 21 minutes (About 30% reduction) in which the operator can tidy up other sources of dirty such as those in the top carter, hidden edges inside the line and those sections which earlier were badly cleaned, increasing the cleaning quality. Through some simple adaptations, as the cleaning of the hopper cover was halved thanks to a more ergonomic cleaning position over the clean bench, the operator ergonomic has been increased, in particular a 16% reduction in cleaning the line (Before was 31 minutes in table 3.1, now accounted for 26) was achieved thanks to a review in activity sequences. Deleting some ones and changing other ones leaded to a reduction of about 37% of the total activities number following the AS-IS and TO-BE scheme in figure 3.1. The introduction of an automatic washing machine let to clean the removal parts of the line unloading work to the operator, except the chute which does not fit in the washing machine. A simple grapple to sustain the garbage bin was inserted in the clean bench avoiding the motion to dispose the wastes during changeover. It was introduced a set of removable spare parts letting the operator to clean the line and changes already cleaned spare parts avoiding the motion to the washing machine and the waiting for cleaning (Internal activities). By this way, it was cut both motion to the washing machine and components cleaning because the original components would be cleaned during the run of the line as external activity (Activity 0.4). In order to conduct this operation well, a set of removable spare parts (Hopper, chute and little hopper) must be available each time a changeover occurs. A 33% reduction in disassembling and reassembling phases (Activities 4, 7 and 10 in table 3.3) was gained through the implementation of the same simple hooks (All the screws were normalized to a size of 5) and components within all the press lines. Furthermore, a carve in the chute was done letting the operator to see rapidly the end stroke of it (Figure 3.3). It was previously indicated with a simple marker.

Figure 3.3. *Old and new chute*



Finally, the standardization of the best procedure, the switch of two activities from internal to external (Phase 0.3 and 0.4 in table 3.3), the introduction of an automatic cleaning machine for removable parts which let the operator to make activities in parallel with the production also thanks to the introduction of already cleaned spare components, were made possible the achievement of the main goal: the reduction of 30% of the whole cleaning changeover time which now accounts for 48,5 minutes (21 minutes less than the AS-IS time in table 3.1). The gained time allows the firm to save energy (Due to the lower consumption per batch) and to increase its capacity, producing the output required in a minor working time. Of course, this is not the real gain for a firm because it must be considered the amortized cost of the washing machine, the cost of the new component (Spare parts) and hooks standardization among all the lines. Furthermore, it must be also considered additional time in conducting the changeover which is still affected by intrinsic variability due to different skilled operators and unforeseen events. All of these statements practically reduce the gained time reached in the new changeover so that the additional items and then the supplementary (Prospective) revenues. No real economic data could be indicated due to industrial secret restriction. Finally, notice that the gain in this process could be affected by the following step (Packaging), so that the gain might be vanished afterwards along the value chain.

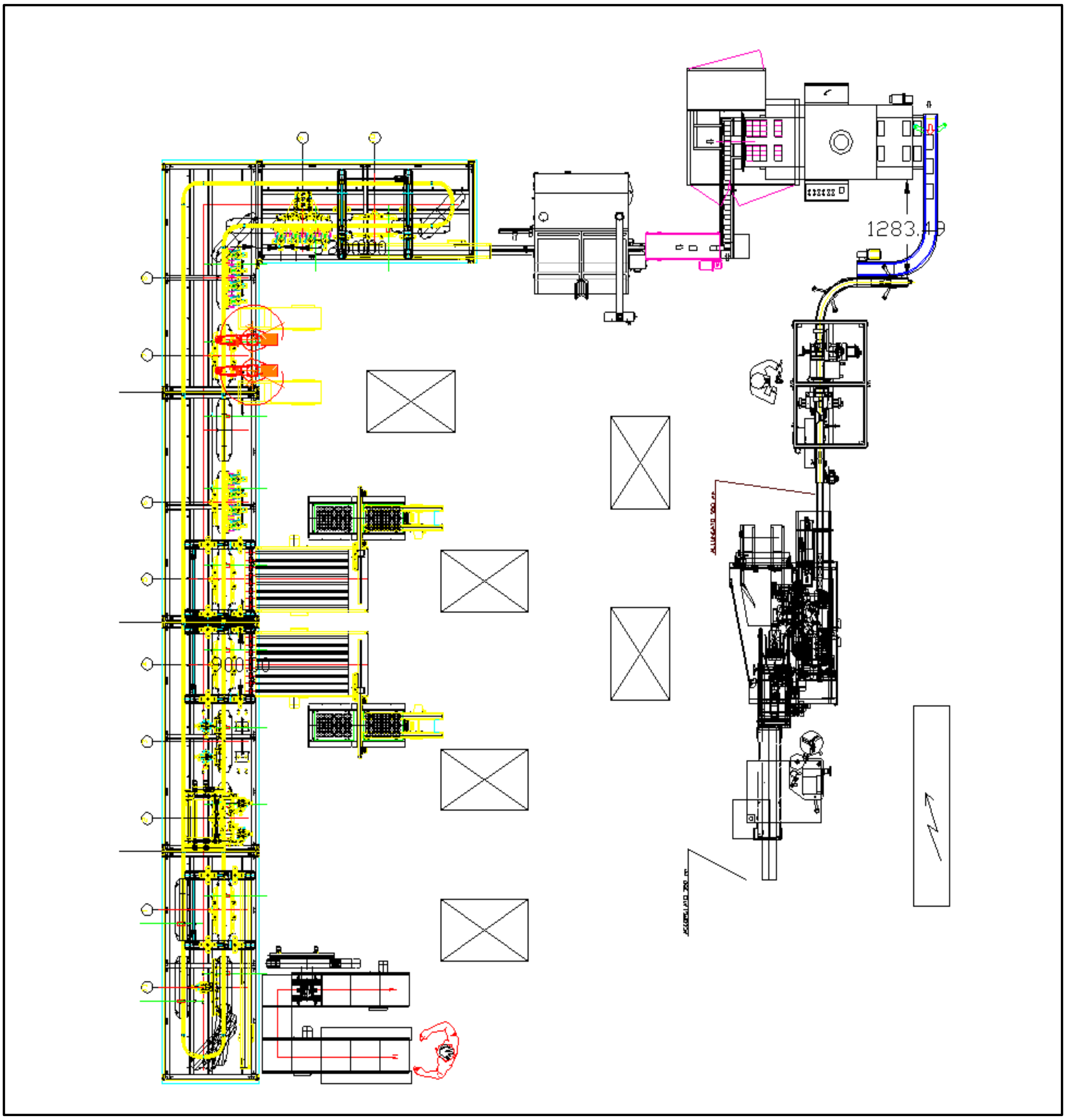
4. APPLICATION OF SMED TO TECHNICAL CHANGEOVER

This chapter inspects how a technical / mechanic changeover is conducted, the action which is needed to switch from working on a type of finished product to another. The type of line analysed (Again directly in the firm, gaining knowledge of the activities sequence and their times) in this changeover is devoted to package the final product using as input, above all, the powder (Semi-worked) treated in the press line discussed in Chapter 3. The novelty in this technical changeover resides on the issue that the product is completely new for the company (New launch) and it does not still fit with the available formats currently adapted to the lines. The type of the interchangeable parts and the combination of them together define a set which results in a specific format of the line. Not all the lines share the same formats, indeed each line might produce several products belonging to different format. This results in the issue that the lines are both specific to the products manufactured and flexible (i.e. they might share formats and then produce the same product). New components were bought to adapt this new product to a line resulting in a new format. The lack of knowledge in conducting the new changeover allows a room for improvements in running it. For this reason, the time in which it is carried out will be very high at least for the first times.

4.1 Case Study Introduction

The technical changeover is more complicated with respect to the cleaning one, indeed it definitively takes more time having more activities to be accomplished. Not only several activities should be done, the changeover should require more efforts in optimizing the procedure as, each of them has to be set accurately because, if not, the process will spend much more time in regulations and adjustments, necessary to obtain the first good item of the new batch. To notice that in a real firm a changeover could be conducted in a more slowly time because there might be an extra time, planned by the firm, to make the changeover before next production batch starts. For instance, if it was scheduled that in a certain period the line should not run in favour of the others (The situation in which all the lines run simultaneously is utopic because it is affected by human resource shortage / constraint), this period, maybe larger than the changeover required time might be devoted to carry out the changeover. Only one observation (AS-IS) will be showed because there were not the chance to make it a second time (Lack of time). It is also noticed that in this case study, as the previous cleaning one, it will be conducted a changeover on an entire line not only on a single machine (Which it is called module). It follows the line layout (Figure 4.1).

Figure 4.1. *Packaging Line Layout* (L’Oréal internal source)



4.2 AS-IS Situation

The product took in consideration is the L'Oréal Palette, a completely new production for the firm which faces the adaptation of one packaging line to the product (New format). The AS-IS changeover is figured out below (Table 4.1).

Table 4.1. *AS-IS Technical Changeover*

	FORMAT CHANGE		
	ACTIVITIES	**TIME (MIN)**	**%**
0.1	Tools supply	2	\
1.	Previous batch declaration, opening new batch	18	4,6%
2.	Spare parts supply	5	1,3%
3.	Shuttles supply	2	0,5%
4.	Shuttles count	1	0,3%
5.	Shuttles replacement	6	1,5%
6.	Previous shuttles repositioning	2	0,5%
7.	Delta head change	4	1,0%
8.	Delta regulation	15	3,9%
9.	Conveyor runner change	3	0,8%
10.	Conveyor terminal change	10	2,6%
11.	Terminal sensors change	7	1,8%
12.	Sensors regulation	2	0,5%
13.	Tweezers of boitier feeder change	8	2,1%
14.	Tweezers regulation	10	2,6%
15.	Tweezers of boitier opener change	14	3,6%
16.	Tweezers regulation	9	2,3%
17.	Glue unit change	35	9,0%
18.	Change of feeder coupelles tweezers and sensors	15	3,9%
19.	Tweezers and sensors regulation	15	3,9%
20.	Coupelles conveyor cover change	13	3,3%
21.	Boitier closer buffer change	14	3,6%
22.	Boitier closer roller change	10	2,6%
23.	Second change of feeder coupelles tweezers and sensors	13	3,3%
24.	Tweezers and sensors regulation	14	3,6%
25.	Labeller change	16	4,1%
26.	Labeller software format change	5	1,3%
27.	Labeller regulation	6	1,5%
28.	Conveyor runner change	4	1,0%
29.	Fardel thrust change	9	2,3%
30.	Fardel labeller height change	5	1,3%
31.	Software format change of fardel labeller	7	1,8%
32.	Fardel labeller height regulation	7	1,8%
33.	Tinning machine fardel change	3	0,8%
34.	Software format change on tinning machine	8	2,1%
35.	Tinning machine regulation	4	1,0%
36.	Complete trial run	70	18,0%
	TOT	389	100,0%

PRELIMINAR EXTERNAL ACTIVITIES	
PRE-CLEANING, PREVIOUS BATCH	
PARAMETERS REGULATION	102

The observed process (Table 4.1), accounted for 389 minutes, shows only one external activity, the supply of work tools (Step 0.1), whereas the supply of the shuttles, which transport items along the chain, and spare parts, are done as internal activities (Steps 2 and 3). To empty the line from the previous batch, which includes the stowing of the packaging articles and semi-worked items, and to load the ones of the following lot will take 18 minutes of the whole process (Step 1). This step allows the deployment of the new items and let the technical support staff to start the changeover. Each time a change in the machines is made will follow a regulation of the parameters in order to verify if the change will result effective for the new production as the change of tweezers, terminals or conveyors; it simply consists in running the line, after the change is made, and see how it works. A lot of time is taken by the activity 17, glue unit change, and due to this reason must be accurately monitored more than other activities but the step which definitively takes the most time of the whole process is surely the last one: trial runs on the whole line (Activity 36), accounted for 70 minutes. This preliminary result is in line with Shingo statement (Paragraph 1.2.9) which affirms that trial run activity often accounts for a big share of the total time devoted to the changeover (Shingo, 1985). As it can be seen in the table 4.1, the observed changeover is composed by several activities and, on the average, each one accounts for a short time to the total process. The overall sum of them let the total to increase a lot. This fact might suggest the adoption of (As much as possible) the same components (Whole parts or even same hooks and gears) within the formats in order to decrease the necessary activities to do. Additionally, it suggests to conduct the work in parallel, sharing duties among support technical staff, in line with the statement of Shingo cited in paragraph 1.2.9 (Shingo, 1985). It is essential to notice that not all modules require physical and technical changes, but someone just needs software adjustments. The overall duration (389 minutes which correspond to about one shift over the three available during the day) is more than the one requested by the firm (It is the first time ever the company performs the changeover of this new product) and it should be decreased in order to gain time for production. Finally, note that the two changeover times (Cleaning and technical) should not be compared as they refer to different type of activities on different machine sizes. As in the chapter 3, the target of the analysis is to reduce as much as possible the time devoted for setup operations.

4.3 Criticality Definition and Case Study Requirements

In this paragraph it will be explained the features of the case study, the necessary tools and the involvement of the stakeholders affected by the study. On the contrary with respect to the previous case (Cleaning changeover), only the involvement of the technical support staff and the technical manager is needed for collecting data and developing a strategy to improve the process. The involvement of the technical support staff team is required because it is composed by the main stakeholders of the study in object and the cooperation with them is recommended for collecting information and data about warehouse storing, technical procedures of the process and utilized tools for the tasks required. Granted that for this type of changeover a design change is often required such as warehouse position, layout structure and type of machines but, it is very difficult to change these variables because the study is conducted in a big and structured firm and changes of this type are often long-lasting or denied for other reasons (For instance, the way of thinking might be oriented to saving money rather than investing a lot with a long term return). First of all, it must be noticed that just one mechanic out of eight knows how to make this changeover. This statement does not mean that only one mechanic knows how to conduct all changeovers in all the lines located in the unit production instead the others cannot, but in this peculiar case characterized by the launch of a new product, the responsibility falls in the best person of the technical support staff which, at least at the beginning, is the solely to carry out the changeover. Then, it is easy to identify the first flaw: the lack of support by the other mechanics which cannot help the one who makes the changeover, they should actually be trained for doing it, and this produces additional costs for the firm spending for aligning all the technical support staff in the future. Indeed, the firm has to train them, decreasing the availability of the technical support staff within the department for a while, further increasing its costs. The availability and the training of the technical support staff hugely affect the duration of the changeover because, as Shingo says (Paragraph 1.2.9), two people working on the line in parallel may reduce changeover time by more than 50% (Shingo, 1985), and this is not actually possible for the firm. Moving from organizational change to technical and procedural ones, the technical support staff spends a huge time devoting to regulate the machines because the hooks and the gears do not allow fast regulations during changeover. Additionally, the balance procedures of the machines (i.e. trial runs) (Once a new mechanic piece is substituted there need time to regulate the sensors in order to correctly read the flow of the items along the chain line) required a lot of time because this process is sometime made as trial and error method.

4.4 Analysis Development and TO-BE Situation

Here is going to be introduced the logic followed to carry out the analysis and the way to deploy the TO-BE situation (Table 4.2) in relation to the flaws observed in the AS-IS one (Table 4.1). It follows the scheme of the AS-IS and TO-BE process which is featured by the same logic of the previous one in chapter 3. It must be observed the actual process (AS-IS situation), store data about it (As sequences and times), find criticalities and reach possible multiple solutions (Moving internal to external activities and try to minimise the time of each one through organizational and technical adaptations) to solve them through brainstorming and the involvement of all stakeholders. Then, applying the changes to the process (The output will be the TO-BE situation) and evaluate the benefits emerged comparing the two situations (Figure 4.2).

Figure 4.2. *AS-IS and TO-BE scheme*

AS-IS AND TO-BE SCHEME

1. Observing the process, storing data about activities and time (Separate internal and external activities).	**OUTPUT: AS-IS SITUATION**
2. Looking at the process observed, analyse it and find critical steps (In terms of ergonomic procedure, quality process and time spent).	**OUTPUT: CRITICALITY INDIVIDUATION**
3. Develop a feasibility study about possible solutions to solve the issues (Switch all possible internal activities to external ones and try to reduce the time spent for each step).	**OUTPUT: ANALYSIS DEVELOPMENT**
4. Starting from the AS-IS situation, apply the changes in the process and store data about activities and time with a second observation.	**OUTPUT: TO-BE SITUATION**
5. Analyse the TO-BE process and compare it to the AS-IS process	**OUTPUT: BENEFITS AND RESULTS**

Looking at the table 4.2 attached below, the steps 2 and 3 could be easily shifted to external activities instead, looking at the existing process (Table 4.1), they are still internals; such as step 4 which represents a (Little) waste of time. Also, the step 6 (Previous shuttles repositioning) might be shifted at the end of the process as external activity, when the line is running again, and not during the changeover. After this first changeover on the new product format, nominal values could be written down and attached close to the modules along the line. This expedient might allow the technical support staff to easily see the input values to insert without spending a lot of time in hardware and software regulations. Probably, the best waste source is that the various product formats do not share the same mechanical components and for this reason, the majority of them have to be changed and adjusted each time a changeover is made. It could be easier to change the product design adapting it to the layout / structure of the machines instead making the contrary and adapting the lines to the product required, indeed many issues might arise when modifications have to be adopted in the line body elements to align them to the product format (Product shape and packaging type) (Braglia, Frosolini, & Gallo, 2016). Unfortunately, this practise is often constrained because the shape of the products is made by Sales Department on the basis of the customer requirements no matter production alignment issues to the fullest. Furthermore, the entire technical support staff team should be learnt about the changeover from the one (Belonged to the team) who make it for the first time and try to get in practise their knowledges. This practise might unlock more human resources capacity. This means mechanics availability as the flexibility of them in doing tasks (Especially the changeover ones). This procedure might be incorporated into the firm as standard procedure for training its technical support staff each time a new changeover appears allowing, again, flexibility related to the availability of the human resources. The impossibility of conducting the changeover in parallel (Two mechanics working simultaneously over the line) reduces a lot the possibility to further decrease the setup time (Paragraph 1.2.9) (Shingo, 1985). Currently, one of the longest activity (Glue unit change, step 13) cannot be decreased due to many reasons. One of them is the difficulty of the technical support staff on the mechanical regulation of the nozzles and the sensors positioning which must be accurately set and this takes a lot of time. The difficulty resides in the type of sensor used: it works detecting the temperature of the glue with respect the packaging and for this reason it is hard to set. Finally, many standardized components could be applied in order to facilitate the setup as the standardization of lock systems and hook gears or easier balance methods. It follows the TO-BE real observation (Table 4.2) after some tangible changes and adjustments from the initially AS-IS situation (Table 4.1).

Table 4.2. *TO-BE Technical Changeover*

	FORMAT CHANGE		
	ACTIVITIES	TIME (MIN)	%
0.1	Tools supply	2	\
0.2	Spare parts supply	5	\
0.3	Shuttles supply	2	\
0.4	Shuttles count	1	\
1.	Previous batch declaration, opening new batch	16	5,3%
2.	Shuttles replacement	6	2,0%
3.	Delta head change	3	1,0%
4.	Delta regulation	10	3,3%
5.	Conveyor runner change	3	1,0%
6.	Conveyor terminal change	8	2,6%
7.	Terminal sensors change	7	2,3%
8.	Sensors regulation	1	0,3%
9.	Tweezers of boitier feeder change	7	2,3%
10.	Tweezers regulation	6	2,0%
11.	Tweezers of boitier opener change	13	4,3%
12.	Tweezers regulation	7	2,3%
13.	Glue unit change	31	10,3%
14.	Change of feeder coupelles tweezers and sensors	14	4,6%
15.	Tweezers and sensors regulation	11	3,6%
16.	Coupelles conveyor cover change	11	3,6%
17.	Boitier closer buffer change	11	3,6%
18.	Boitier closer roller change	10	3,3%
19.	Second change of feeder coupelles tweezers and sensors	12	4,0%
20.	Tweezers and sensors regulation	10	3,3%
21.	Labeller change	14	4,6%
22.	Labeller software format change	2	0,7%
23.	Labeller regulation	6	2,0%
24.	Conveyor runner change	3	1,0%
25.	Fardel thrust change	8	2,6%
26.	Fardel labeller height change	3	1,0%
27.	Software format change of fardel labeller	2	0,7%
28.	Fardel labeller height regulation	3	1,0%
29.	Tinning machine fardel change	3	1,0%
30.	Software format change on tinning machine	4	1,3%
31.	Tinning machine regulation	4	1,3%
32.	Complete trial run	53	17,5%
0.5	Previous shuttles repositioning	3	\
	TOT	302	100,0%

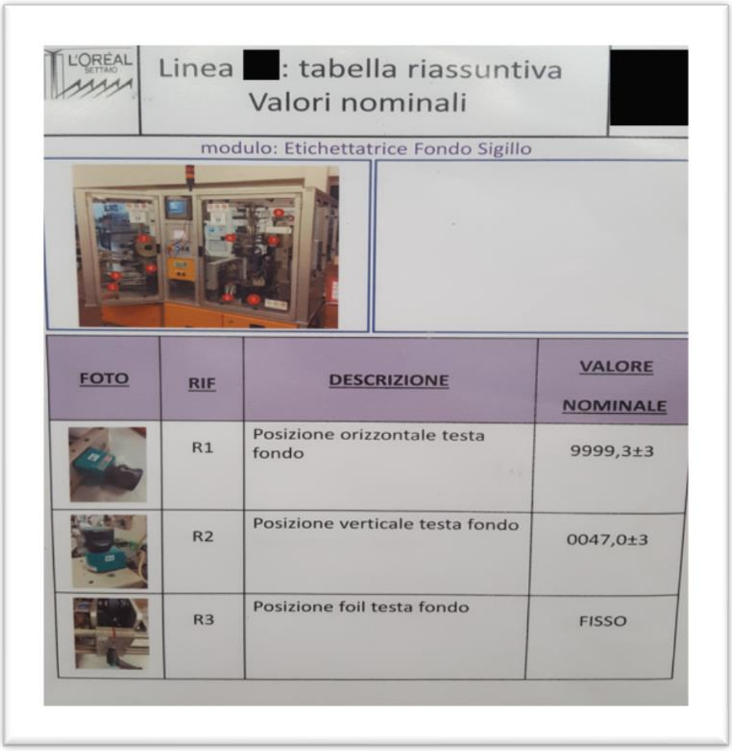
PRELIMINAR EXTERNAL ACTIVITIES	
FOLLOWING EXTERNAL ACTIVITIES	
PRE-CLEANING, PREVIOUS BATCH	
PARAMETERS REGULATION	66

4.5 Benefit Analysis AS-IS_TO-BE and Results

Real and proved improvements have been made in the process as they can be seen as follow comparing the previous AS-IS situation (Table 4.1) with the TO-BE one (Table 4.2).

Four internal activities were shifted to external ones, the supply of shuttles and spare parts as well the count of the shuttles required for the new production (Phases 0.1, 0.2, 0.3 and 0.4 of TO-BE). The shuttles repositioning activity was put at the end of the process, after the new production batch starts (i.e. concealed / hidden time, phase 0.5). A huge time in the changeover process was saved thanks to the adoption of nominal values attached close to the modules of the line as a reference for the technical support staff which now can acquire software and hardware values in a fraction of time without wastes in trial processes. So that, each parameter regulation after the installation of a new component along the line (Or software program change) is faster than the AS-IS situation (Table 4.1). This trick allowed to save a 35% of time spent in regulations which now just accounted for 66 minutes (Table 4.2) with respect to the previous observation in which regulations time was of 102 minutes (Table 4.1). It follows an example of nominal values (Figure 4.3).

Figure 4.3 *Nominal Values*


L'ORÉAL SETTIMO

Linea [redacted]: tabella riassuntiva
Valori nominali

modulo: Etichettatrice Fondo Sigillo

FOTO	RIF	DESCRIZIONE	VALORE NOMINALE
	R1	Posizione orizzontale testa fondo	9999,3±3
	R2	Posizione verticale testa fondo	0047,0±3
	R3	Posizione foil testa fondo	FISSO

Furthermore, looking at the TO-BE situation, some activities were conducted in a decreased time by the technical support staff which learned from the first changeover, increasing its know-how about it. This achievement was also reached through the implementation of some new hook gears which allow a faster regulation by technical support staff on several activities which comprehend the change of components. Also, the final / complete trial run time decreased thanks to the higher accuracy of the technical support staff through the introduction of nominal values. The adoption of nominal values allowed multiple benefits. Unfortunately, the whole standardization of the fast hook gears and components within various formats is hard to reach because it requires the overall change of the products to be manufactured and the inventory related to the warehouse. Despite the implementation of the standard procedure was made, aiming to share knowledge among technical support staff about the changeovers, the firm faces the impossibility to assign more than one mechanic to the changeover activity due to the availability of the technical support staff team. This constraint might restrict the potential reduction of setup time. Overall, the most important achievement of the AS-IS_TO-BE analysis was the reduction of setup time by 22% (302 total minutes). Again, the cost benefit could be supposed making some assumptions (No real economic data due to industrial secrets). The 22% reduction of changeover time, again, means more time for production, faster time to market and increased capacity. It might reduce defects (Due to a more accurate trial run) and might allow a faster production start in producing the first good item of the batch having been decreased the ramp-up time. Also, this process is affected by intrinsic variability and for this reason, as in the cleaning case, these values cannot be considered truthful. The difference resides on the fact that the output of the packaging line (Final process) is the product ready to sell, so a gain in this step is somehow deterministic, instead the output of the press line is a semi-worked that has to be processed again, and then the achievement made in this process could be vanished afterwards along the value chain.

5. CONCLUSIONS

In this final chapter it will be summarized the achievements and benefits of the thesis and its added value to the firm. Furthermore, it will be listed a set of applicability limits which have constrained the development of the thesis in terms of time, resources and environment. Finally, only after having collected both the benefits for the firm and the intrinsic limits, especially in the case studies of the thesis, it will be discussed the possible future steps for the firm in the light of continuous improvement in line with the topic faced in the thesis.

5.1 Thesis Benefits for the Firm

The aim of the thesis was to apply Single Minute Exchange of Die (SMED) in the cosmetic industry through two case studies developed thanks to the production engineer internship in the cosmetics powder production unit inside the L'Oréal Settimo Torinese plant during the period from October 2017 to April 2018. The technical changeover case study (Chapter 4) was performed due to the reason of the new product launch of the firm. The novelty, indeed, resided on the issue that, having a new product / launch in the market, the format applied in the line within the production unit was completely new and there was a ground for improvements. Remembering that a set of interchangeable mechanical and software parts which could be assembled to the line in order to produce one or more products that share a similar physical structure, defines a specific format of the line. To reinforce the knowledge and to increase the chance of better exploiting the results it was documented another case study (Chapter 3) concerned a cleaning changeover, for developing in conjunction to the first. To notice that the analysis of the cleaning changeover case study started before the technical one because the production of the new product began around December 2017. This parallel work has reinforced the value of the thesis letting to analyse and develop two types of changeover from different points of view, following the SMED method by Shingo. Remembering that the goal of the two was the same, the reduction as much as possible of setup time, in order to gain additional available time for production purpose, this achievement might be also spent for non-production purpose as in the cleaning changeover (Chapter 3) in which the achieved time reduction might be devoted to a deeply cleaning of the line increasing the quality of the process in favour of the customers. To notice, however, that a comparison is conceivable only with some constrains because the two types of changeover, despite they share the same goal, are definitely different about the time spent in doing them, the involvement of the stakeholders and the knowledge required for conducting them. As it seen in the Chapter 3, analysing and processing the cleaning activities with the AS-IS and TO-BE analysis, through some sequence adaptations in the process, the review of the activities and some technical and organizational changes, it was achieved a set of different benefits as the improvement of process quality, through the switch from a bigger terminal size of the aspiration tube to a narrower one, letting to clean also hidden edges inside the line, the development of different activities which let a better ergonomic operations and lastly a setup time reduction unlocking more time for production or for cleaning activities. The standardization of the hooks and some removable components offered a ground for improvement, decreasing the disassembling and reassembling components phases. Finally, the introduction of a new washing machine for removable components and the implementation of spare parts already cleaned, have let to clean the dirty components as external activity during run time of the line, decreasing again the setup time devoted to the changeover. Instead, regarding the technical changeover, a weakness sequence review was done because the process is strongly rigid in terms of activity sequences. Indeed, the activities have remained somehow the same. Only four activities were switched from internal to external decreasing a bit the total setup time. A little wasting time was deleted thanks to a replacing of some simpler hooks allowing a faster change of components. The best action was to attach the nominal values close to the modules reaching a minor time spent in regulation of the parameters. Then, the natural know-how improvement about the changeover among the technical support staff has allowed to save additional time. This know-how will increase each time a changeover is conducted until an upper bound is going to occur, beyond that it will be not possible to achieve more reduction time in the process being a sort of bottleneck of it. Apart from the punctual benefits, the thesis work has given the opportunity to develop more general benefits for the firm. These benefits reside in the achievement and development of SMED topic, the increased awareness of an accurate analysis as an improvement opportunity for the production unit. The capacity and the flexibility reached with the work have allowed a better production in terms of time, ergonomics and quality, having achieved a more efficient changeover from quality and hygiene point of view. The thesis has offered the opportunity to develop and maintain the standardization of the best practices and procedures, the Lean culture and the evolution of Performance attitude. The more reliability in the changeover activities was achieved through the change in the attitude of the operators which have been internalised additional competencies, ensuring the results achieved in time.

5.2 Applicability Limits

The thesis keeps some applicability limits in relation to the study conducted in the application of the SMED approach inside the firm. Due to the limited observation period of the thesis, concerning the two case studies, it was not possible to check and verify some proposed long-term improvements. One of them concerns the Total Productive Maintenance (TPM) application which is weak utilized. The lack of a sorted and organized spare parts warehouse increases the time spent by the technical support staff in localising and finding the right piece or tool needed. This constraint directly impacts on the changeover, increasing the time in conducting it. The warehouse management would be another goal in the minimization of changeover setup time if the thesis period was longer than the real one. For instance, the sorting of all spare parts belonged to the different formats and the clustering of them close to lines would be another goal of the thesis. Additionally, the tools required for the changeover would have the same position and grouped together based on their functions. Furthermore, the absence of a preventive maintenance decreases a lot the Mean Time To Failure (MTTF) of the machines incurring in more and more breakdowns reducing the availability of the technical support staff within the production unit, besides of the higher downtimes which decreases time for production. Indeed, no improvements were done in relation to the parallel work changeover conduction. The relatively poor training of the technical support staff which not always is aligned in terms of know-how about the various changeovers limits the availability of the mechanics to execute a specific job and to develop the SMED and Lean culture within the production unit. In practise, a part of them focuses on the press lines issues, the others on the packaging lines ones. If, in a certain period, some of them took a holiday or an ailment, it would be hard to manage the unit production when certain breakdown events occur. Same issue for the availability of the operators who work in the line. This sort of personnel unavailability and the lack of time in conducting the thesis constrained the work in terms of observations number and support by the technical internal staff. Another limit in the application of the technical changeover is the lack of totally shared and standardized components, such as hooks, gears and screws, because of the limited yearly budget. If the firm faced always same mechanical pieces among various formats, same hooks and detachments, always considering physical and technical constraints, it would have a less types of components, in general less things to deal with. This would reduce a lot the variability of the processes, from the supply management to the changeovers.

5.3 Future Steps for the Firm

The firm is well structured and most of the processes are standardized then it is hard to change the layout structure and the established procedures. However, collecting data from the analysis about the firm changeovers, some future steps might be suggested in order to obtain more value from the production processes. With respect to the cleaning changeover it might be modified the hopper cover (Carter) uncovering it from the top to the anterior side to avoid the motions of the operators in the disassembling phase. The short-term future steps for the firm might also be the extension of the results achieved with the thesis in the two lines (Press line and packaging line) to all other lines currently existing in the production unit which would allow to increase the chance to standardise the improvements and extend them, expanding the know-how. The replacement of all changeovers with the optimized one, in terms of activities and practices, and the alignment of all the operators in conducting the changeover likewise would allow the firm to exploit multiple benefits keeping its growth. In the future the TPM concept might be stronger than nowadays. The introduction of a better organized and sorted spare parts and tools warehouse would allow a faster looking for materials by the operators and, above all, the technical support staff. This better organization would afford to reach a decreased setup time during all type of changeovers and less time to intervene when breakdowns occur because each component is definitely positioned. An organized warehouse lets to easily see when a spare part is currently in stock or it lacks, allowing faster procurement and reducing the supply time. The warehouse is still sorted by screw types and their dimensions and some spare parts are organized close one each other function of their applications. The total warehouse sorting, group together parts which share the same function or the same line, is affordable for the firm in a short-term period. A collection of historical data about breakdowns would has some long-term benefits for the firm. The most important is the implementation of a preventive maintenance which cannot be deployed without the collection of data about the machines. The firm has moved toward this direction starting from the collection of historical data, but it needs time and efforts to carry on and maintain this good practise. Overall, in an ideal world, if the lines shared the same standardized components, distinguishing press lines from packaging ones, it would be easier and faster to intervene for breakdowns, firstly because the components would be somehow the same, also the know-how of the technical support staff would rely on dealing with the same type of reestablishments. The changeover times would face a drastic reduction because there will not be anymore the necessity to change several components each time a different product has to be manufactured. This means versatility. The variability of the processes would be reduced letting issues and mistakes to easily emerge. Finally, it is required to say that the firm is very proactive concerning the operators and mechanics training, in general all the stakeholders and employees. For instance, if a new technician (From a supplier) comes for the first time in the Settimo Torinese plant to make a job, he has to be trained from L'Oréal before he starts the work. Nevertheless, more efforts might be done in this direction in order to increase the competences and the skills of the employees letting the firm to persistently grow.

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